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ORIGINAL RESEARCH

Improving Nutritional Status in Chronic Heart Failure Patients: Effectiveness of a Transtheoretical Model-Based Stepwise Nutritional Management Program

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Objective: To explore the nutritional status of chronic heart failure (CHF) patients and evaluate the effect of a transtheoretical model-based stepwise nutritional management program on nutritional improvement.

Methods: This study conducted a retrospective analysis of 100 chronic heart failure (CHF) patients admitted to our hospital from March 2023 to May 2024. After applying inclusion and exclusion criteria, the patients were divided into an observation group and a control group. The observation group received a stepwise nutritional management program based on the transtheoretical model (TTM), while the control group received routine care. Nutritional improvement and clinical effects were compared between the two groups.

Results: Among the 100 CHF patients, 27% had good nutritional status, 42% were at nutritional risk, and 31% had malnutrition. No significant differences in baseline data were found between the two groups ($P > 0.05$). After the intervention, the observation group showed significantly lower B-type natriuretic peptide (BNP) levels and higher left ventricular ejection fraction (LVEF) levels compared to the control group ($P < 0.05$). Psychological scores (Self-Rating Depression Scale (SDS) and Self-Rating Anxiety Scale (SAS)) in the observation group were also significantly lower than those in the control group ($P < 0.05$). Additionally, serum total cholesterol (TC) and triglycerides (TG) levels were lower in the observation group ($P < 0.05$), and levels of prealbumin, transferrin, hemoglobin, and albumin were higher ($P < 0.05$). The Minnesota Living with Heart Failure Questionnaire (MLHFQ) scores in the observation group were significantly lower than in the control group ($P < 0.05$).

Conclusion: The nutritional status of CHF patients is generally poor, and the transtheoretical model-based stepwise nutritional management program can effectively improve their nutritional status, enhance cardiac function, improve quality of life, and alleviate psychological burden. This intervention is promising for clinical practice.

Keywords: chronic heart failure, nutritional status, transtheoretical model, stepwise nutritional management, quality of life

Introduction

Chronic heart failure (CHF) refers to a syndrome caused by structural or functional abnormalities in the heart, leading to impaired ejection or filling functions, which in turn result in a series of hemodynamic and neurohumoral abnormalities.[1] Heart failure (HF) has evolved into a global epidemic, with an estimated prevalence exceeding 37.7 million individuals worldwide. In the United States alone, approximately 6.2 million adults currently live with HF, and over 870,000 new cases are diagnosed annually.[2] Developing nations are undergoing an epidemiological transition, with HF-related hospitalizations tripling in some regions over the past two decades.[3] This surge imposes a staggering economic burden: projections indicate that HF-associated medical costs in the US will escalate from 30.7 billion in 2020 to 69.8 billion by 2030.[4] Despite therapeutic advances, the 5-year mortality rate remains as high as 50%, underscoring the urgent need for

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innovative management strategies.[5] As such, effectively managing CHF patients, delaying disease progression, and improving their quality of life have become important challenges for the medical community.[6]

Among the pathophysiological mechanisms of CHF, malnutrition is considered one of the key factors in disease progression. The pathophysiology of malnutrition in CHF is multifactorial. Chronic systemic congestion impairs intestinal absorption through hepatic and mesenteric venous hypertension, while neurohormonal activation (eg, elevated TNF-α and IL-6) accelerates muscle protein breakdown.[7] Additionally, reduced cardiac output diminishes peripheral oxygen delivery, shifting metabolism toward catabolism and exacerbating skeletal muscle wasting.[8] These mechanisms collectively contribute to cardiac cachexia – a syndrome characterized by unintentional weight loss (>5% in 12 months), diminished fat reserves, and hypoalbuminemia.[9] This deterioration in nutritional status not only reduces patients' exercise tolerance but also significantly increases mortality risk. Despite the important role of nutritional management in the treatment of CHF, traditional nutritional interventions often focus on singular nutritional supplementation, lacking personalization and systematic approaches, which results in limited patient compliance and effectiveness.

Current nutritional interventions for CHF predominantly follow a "one-size-fits-all" approach. While guidelines emphasize sodium restriction (<2 g/day) and fluid management, real-world implementation faces critical challenges. First, static dietary prescriptions often neglect patients' behavioral readiness – a key determinant of long-term adherence.[10] Second, traditional interventions focus narrowly on macronutrient intake (eg, protein supplementation) while overlooking psychosocial barriers, such as depression-related appetite loss (prevalence: 28–42% in CHF cohorts).[11] Third, existing programs rarely address the stage-specific needs of patients, with 67% of CHF patients in a multicenter survey reporting difficulty maintaining prescribed diets beyond 3 months.[12] These gaps highlight the necessity for personalized, theory-driven nutritional strategies.

As the needs for CHF patient management become increasingly diverse and complex, adopting more scientific and systematic nutritional interventions has become an inevitable trend. The Transtheoretical Model (TTM) offers distinct advantages over other behavioral frameworks (eg, Health Belief Model or Social Cognitive Theory) for CHF nutritional management. Unlike approaches focusing solely on knowledge acquisition, TTM's stage-matched interventions (pre-contemplation → maintenance) align with the fluctuating motivation patterns observed in CHF patients. For instance, during the "contemplation stage", cognitive reappraisal techniques address fatalism ("My heart is too weak for diet changes"), whereas "action stage" strategies utilize meal planning tools compatible with fluid restrictions.[13] This phased approach has demonstrated superior efficacy in chronic disease cohorts: a meta-analysis of 33 RCTs showed TTM-based interventions improved dietary adherence by 41% compared to standard education (95% CI: 29–53%, $p<0.001$).[14]

To our knowledge, no prior study has systematically applied TTM to nutritional management in CHF. Previous trials primarily focused on isolated components (eg, micronutrient supplementation in SICA-HF trial[15]) or short-term weight monitoring (eg, GISSI-HF protocol).[16]

This study introduces the TTM theory and designs a stepwise, graded nutritional management program. Through a retrospective analysis of data from CHF patients who received this intervention, the study aims to systematically assess its effects on improving nutritional status, cardiac function, and quality of life, in order to provide scientific evidence for clinical practice. The main objectives of this study include: exploring the nutritional status of CHF patients, validating the feasibility and effectiveness of the TTM-based stepwise graded nutritional management program, providing new ideas for comprehensive CHF management, and promoting the refined development of nutritional interventions. The study also aims to offer insights and references for chronic disease management.

Participants and Methods

Study Participants

This study conducted a retrospective review of cases from our hospital. We selected chronic heart failure (CHF) patients who were admitted between March 2023 and May 2024, ensuring the sample was representative. After rigorous screening for inclusion criteria, a total of 100 patients were enrolled in the study. To minimize selection bias, patients were allocated to the control and observation groups based on their admission sequence: the first 50 eligible patients were assigned to the control group (conventional intervention), and the subsequent 50 patients to the observation group

(stepwise graded nutritional management). All patients' nutritional statuses were analyzed. This study was approved by the ethics committee of the First Affiliated Hospital of Soochow University and conducted in accordance with the principles of the Declaration of Helsinki. Given the retrospective nature of the study, the institutional review board waived the requirement for informed consent. All persons who come into contact with any personal data and record patient information follow the code of confidentiality.

Rationale for sample size: A post-hoc power analysis was performed using G*Power 3.1, assuming an effect size of 0.5 (moderate), $\alpha = 0.05$, and power = 0.8. The analysis indicated that a total sample size of 100 patients (50 per group) was adequate to detect significant differences in nutritional outcomes.

Inclusion and Exclusion Criteria

Inclusion Criteria

Diagnosis of chronic heart failure according to clinical standards.[17,18]

NYHA (New York Heart Association) functional classification of II or III.

Complete clinical data available.

Ability to communicate and understand instructions.

Exclusion Criteria

Patients with comorbidities such as acute myocardial infarction, respiratory failure, or angina.

Patients with severe liver or kidney dysfunction.

Patients with malignant tumors.

Patients with congenital heart disease.

Patients with mental or cognitive impairments.

Methods

The control group received conventional intervention, where nursing staff strengthened oral education with patients, reminding them to follow medical instructions for medication use, and to pay attention to relevant dietary and lifestyle matters. Patients were advised to follow a light diet and avoid high-sugar, high-fat foods. They were also instructed to manage self-care after discharge, with family members ensuring proper monitoring, and patients were reminded to attend follow-up visits.

The observation group received a stepwise graded nutritional management program based on the Transtheoretical Model. This program is a phased, dynamically adjusted comprehensive nutrition intervention model specifically designed for chronic heart failure (CHF) patients. It involves graded management based on the patient's nutritional status, the severity of their condition, and the treatment phase, ensuring the scientific and individualized nature of the nutrition intervention. The Transtheoretical Model (TTM) is a psychological theory of behavior change that focuses on the psychological aspects of health and provides targeted nursing interventions to improve patients' health behaviors and enhance their quality of life.[19,20] This program was implemented throughout the diagnosis and treatment process, as follows:

Level 1 Management

Basic Nutritional Intervention (Initial Assessment Phase)

Objective: Correct potential nutritional risk and meet basic metabolic requirements.

Measures

Nutritional Risk Screening: Nutritional status was assessed using the NRS-2002 and MNA-SF tools, including factors such as weight changes, appetite, and chewing and swallowing function. NRS-2002 scores were calculated based on pre-existing clinical records, including weight loss, dietary intake reduction, and disease severity. MNA-SF assessments were retrospectively extracted from nursing documentation, which evaluated body mass index, appetite, and mobility status.

Dietary Adjustment: Based on the "Dietary Reference Intakes for Chinese Residents" (2022), an initial dietary plan was developed to ensure daily energy and protein intake met the recommended levels. Individualized dietary adjustments

were guided by baseline MNA-HF scores, serum albumin levels, and comorbidities (eg, diabetes or renal dysfunction). Sodium and fluid restrictions were modified according to daily weight measurements documented in medical records.

Health Education: Nutritional knowledge was provided to both patients and their families, emphasizing the importance of a balanced diet in managing the condition.

Level 2 Management

Individualized Nutritional Support (Stable Treatment Phase)

Objective: Optimize nutrient intake, improve physical condition and immune function, and reduce disease burden.

Measures

Precise Nutrient Allocation: The ratio of fats, proteins, and carbohydrates was optimized according to the patient's condition and lifestyle, with sodium intake strictly limited (no more than 2g per day) and fluid intake controlled (approximately 1000–1500 mL/day).

Dietary Variety: Dietary diversity was increased, with a focus on foods rich in dietary fiber, vitamins, and antioxidants such as dark green vegetables, whole grains, and fruits, to enhance the appeal and acceptability of the diet.

Nutritional Supplementation: When necessary, high-protein or energy supplements were added to improve nutritional deficiencies.

Level 3 Management

Intensive Nutritional Intervention (Complicated or Acute Phase)

Objective: Provide supportive therapy, enhance metabolic tolerance, and alleviate complications due to malnutrition.

Measures

Enteral or Parenteral Nutrition: For patients with severe malnutrition or swallowing difficulties, enteral nutrition (eg, tube feeding) or parenteral nutrition (eg, intravenous infusion) was used to ensure adequate energy and protein supply.

Intensive Monitoring: Weekly assessments of body weight, biochemical indicators (such as vitamin B1, B12, and electrolyte levels), inflammatory markers, and functional status.

Treatment Support: Nutrition plans were adjusted in combination with pharmacological treatments, avoiding electrolyte imbalances or excessive fluid load that could worsen heart failure symptoms.

Emergency Adjustments: For patients unable to maintain nutritional balance or experiencing metabolic disorders, a temporary enhanced support plan was formulated, gradually transitioning back to standard nutritional interventions.

Level 4 Management

Long-Term Maintenance and Monitoring (Recovery and Remission Phase)

Objective: Consolidate nutritional intervention outcomes, reduce the risk of disease recurrence, and improve the patient's quality of life.

Measures

Long-Term Dietary Planning: A balanced diet was maintained, with adjustments to food types and proportions, strengthening the intake of fiber-rich and antioxidant-rich foods.

Dietary Habit Formation: Through family involvement and social activities, patients were encouraged to form healthy eating habits.

Regular Follow-Up: Monthly monitoring of body weight, nutritional status, and quality of life was conducted, with management optimization through a multidisciplinary team (including doctors, nutritionists, and psychological counselors).

Additionally, psychological interventions were integrated throughout the entire management process. A comprehensive evaluation of the patient's cognitive function, emotional status, and lifestyle habits was conducted, identifying factors influencing emotional changes and developing targeted interventions. Weekly group psychological counseling was organized, which included educational videos, Q&A sessions, and promoting patient experience sharing, to help patients understand their condition, improve self-management, and build confidence in overcoming the illness.

Nursing staff provided one-on-one psychological communication daily, encouraging patients to express their feelings, correct maladaptive thinking, focus on positive aspects of life, and reduce psychological burden. Patients were also guided to regulate negative emotions, understand their adverse effects on the condition, and encouraged to engage in social activities and hobbies to shift their focus away from the disease.

Observation Indicators

Adherence Assessment: Intervention adherence was evaluated through nursing notes documenting dietary compliance (eg, meal consumption logs), family-reported adherence during follow-up calls, and biochemical markers (eg, serum sodium levels reflecting fluid restriction).

Outcome Assessor Blinding: Biochemical and echocardiographic data were analyzed by laboratory technicians blinded to group allocation. Psychological assessments (SAS/SDS) were administered by independent researchers unaware of intervention assignments.

Baseline Data: Collected within 24 hours of admission (demographics, MNA-HF, blood tests).

Follow-up Data: Post-intervention outcomes (nutritional status, cardiac function) were assessed at discharge and during the first scheduled outpatient visit (30 ± 7 days post-discharge).

Dietary Structure: Dietary information was collected from patients using a 24-hour dietary recall questionnaire. The dietary structure was then analyzed with reference to dietary guidelines.

Nutritional Status: Nutritional status before and after intervention was assessed using the MNA-HF scale. The scale consists of four sections with a total of 15 items: Anthropometric measurements (5 items), Dietary assessment (5 items), Overall evaluation (3 items), and Self-assessment (2 items), with a total score of 29 points. Scoring standards are as follows: ≥22 points indicates normal nutrition, 16–21 points indicates risk of malnutrition, and <16 points indicates malnutrition. Additionally, 5 mL of blood was drawn from the patient's antecubital vein, and serum albumin levels were measured using enzyme-linked immunosorbent assay (ELISA) after centrifugation at 3000 r/min for 10 minutes (centrifugal radius 10 cm).

Cardiac Function: Brain natriuretic peptide (BNP) levels were measured from venous blood samples. Left ventricular ejection fraction (LVEF) was assessed using echocardiography to evaluate cardiac function.

Psychological Status: Anxiety and depression were evaluated using the Self-Rating Anxiety Scale (SAS) and the Self-Rating Depression Scale (SDS). The critical threshold for SAS is 53, and for SDS is 50. Scores below the critical value indicate better psychological status, while scores above the threshold indicate increasing severity of anxiety or depression symptoms.

Blood Lipid Levels: Morning fasting venous blood (4 mL) was collected from patients. After centrifugation at 4000 r/min for 15 minutes (centrifugal radius 10 cm), serum levels of total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were measured using an enzymatic colorimetric method.

Nutritional Improvement: Fasting venous blood (5 mL) was collected from patients before and after intervention. The blood was processed using a centrifuge at 3000 r/min for 5 minutes, and the supernatant was analyzed for prealbumin (PA), transferrin (TF), hemoglobin (Hb), and albumin (ALB) levels using an automated biochemical analyzer to assess changes in nutritional status.

Quality of Life: The Minnesota Living with Heart Failure Questionnaire (MLHFQ) was used to assess the quality of life before and after intervention. The questionnaire covers four areas: physical limitation, emotional state, social limitation, and symptoms, with a total of 21 items. Each item is scored from 0 to 5 based on severity, with a total score of 105 points. A lower score indicates better quality of life.

Statistical Data

Data analysis was performed using SPSS 26.0 software, and GraphPad Prism 8 software was used for image processing. Normality was verified using Shapiro–Wilk tests. Non-normally distributed variables (eg, BNP levels) were analyzed with Mann–Whitney *U*-tests. Bonferroni correction was applied for multiple comparisons (adjusted $\alpha = 0.01$ for 5

primary outcomes). Quantitative data were expressed as mean ± standard deviation, and comparisons between groups were conducted using independent-sample t-tests. A p-value of <0.05 was considered statistically significant.

Results

Dietary Structure

The daily intake of vegetables, soy products, and nuts among chronic heart failure (CHF) patients met the recommended standards of the dietary guidelines. However, the intake of grains and legumes, fruits, dairy products, and dairy products was lower than the recommended amounts, while the intake of meat, poultry, fish, eggs, oils, and salt exceeded the reasonable limits set by the dietary guidelines. See Table 1.

Nutritional Status

Among the 100 chronic heart failure (CHF) patients, 27.00% had normal nutritional status (MNA-HF score ≥ 22); 42.00% were at nutritional risk (MNA-HF score between 16 and 22); and 31.00% had nutritional deficiencies (MNA-HF score < 16). See Figure 1.

General Information

In the observation group, there were 50 patients, including 27 males and 23 females, with an average age of 60.88 ± 5.21 years and a disease duration of 6.11 ± 1.03 years. In the control group, there were also 50 patients, including 28 males and 22 females, with an average age of 61.03 ± 5.44 years and a disease duration of 6.28 ± 0.97 years. No significant differences were found in the general information between the observation group and the control group (P > 0.05). See Table 2.

Cardiac Function

There was no significant difference in cardiac function between the two groups before the intervention (P > 0.05). After the intervention, the BNP levels in the observation group were lower than those in the control group, and the LVEF levels in the observation group were higher than those in the control group, with all P < 0.05. See Table 3.

Psychological Status

After the intervention, the SDS and SAS scores in the observation group were lower than those in the control group, with all P < 0.05. See Figure 2.

Table 1 Dietary Structure Analysis of Chronic Heart Failure Patients

	Mean Daily Intake of Patients	Recommended Values in Dietary Guidelines
Vegetable	411.56±156.65	300–500
Soybeans and nuts	26.94±10.56	25–35
Grains, potatoes, and mixed beans	188.25±89.65	250–400
Fruits	58.45±28.45	200–350
Milk and dairy products	71.98±47.96	300
Livestock and poultry meat	156.21±99.54	40–75
Aquatic product	95.65±33.45	40–75
Eggs	57.56±15.77	40–50
Oils and fats	47.56±11.56	25–30
Salt	14.65±8.86	<6

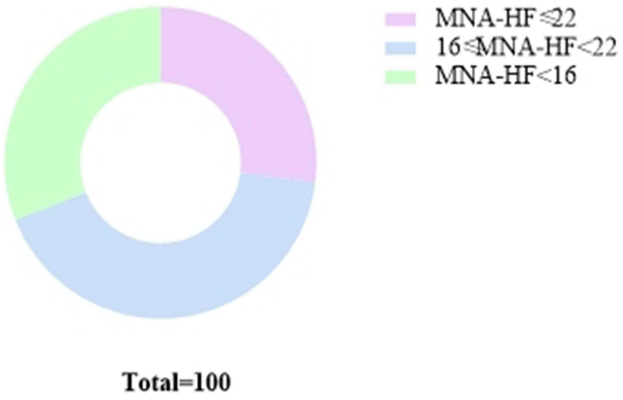

Figure 1 Nutritional Status Analysis of Chronic Heart Failure Patients.

Lipid Levels

After the intervention, there was no significant difference in HDL-C and LDL-C levels between the two groups ($P > 0.05$). However, the serum TC and TG levels were lower in the observation group compared to the control group, with all $P < 0.05$. See Figure 3.

Nutritional Improvement

After the intervention, the levels of prealbumin, transferrin, hemoglobin, and albumin in the observation group were higher than those in the control group, with all $P < 0.05$. See Figure 4.

Quality of Life

After the intervention, the MLHFQ scores of the observation group were lower than those of the control group, $P < 0.05$. See Figure 5.

Discussion

This study aims to explore the nutritional status of chronic heart failure (CHF) patients and the improvement effects of a stepwise, graded nutritional management program based on the Transtheoretical Model (TTM). As a complex clinical

Table 2 Comparison of General Information Between the Two Groups

		Observation Group	Control Group	t	P
Number of Cases	–	50	50	–	–
Gender	Male	27	28	–	–
–	Female	23	22	–	–
Age	Mean	60.88±5.21	61.03±5.44	0.089	0.930
Course of disease	Mean	6.11±1.03	6.28±0.97	0.537	0.594

Table 3 Comparison of BNP and LVEF Levels Between the Two Groups

		Observation Group	Control Group	t	P
Number of Cases	–	50	50	–	–
Before	BNP (ng/L)	701.65±156.12	721.52±205.66	0.344	0.733
–	LVEF (%)	47.03±10.89	47.11±10.56	0.024	0.981
After	BNP (ng/L)	325.15±88.45	589.56±112.25	8.274	<0.001
–	LVEF (%)	59.89±9.45	51.07±12.55	2.511	0.016

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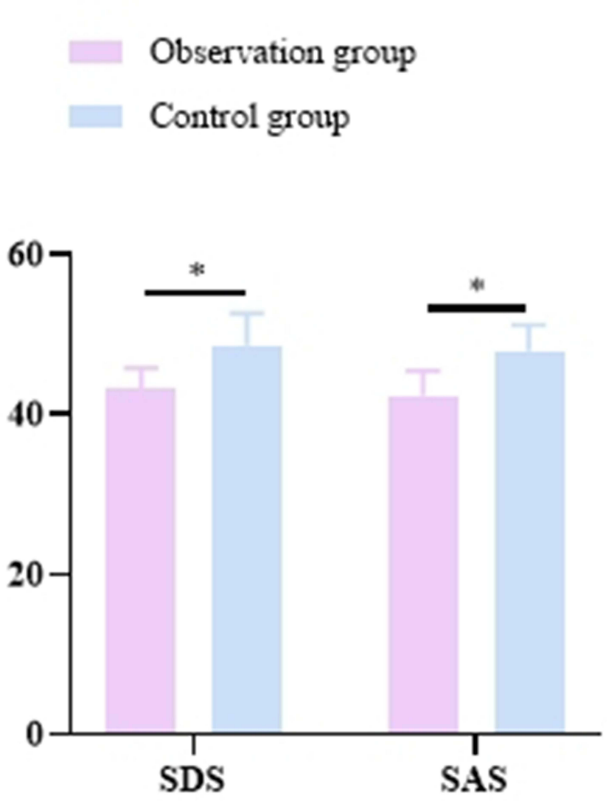

Figure 2 Analysis of Anxiety and Depression Status in Both Groups.
Note: * indicates a statistically significant difference, P < 0.05.

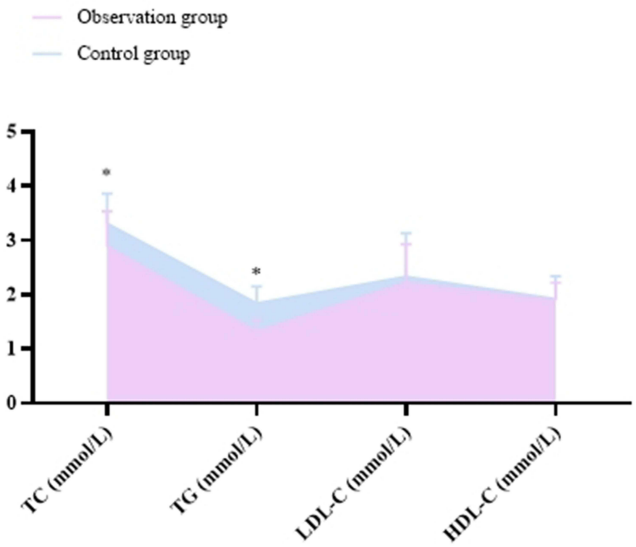

Figure 3 Comparison of Lipid Profile Indicators Between the Two Groups.
Note: * indicates a statistically significant difference, P < 0.05.

syndrome, CHF has a profound impact on the prognosis and quality of life of patients, particularly due to issues related to malnutrition. Through systematic nutritional risk screening and intervention, this study hopes to improve patients' overall health status with appropriate nutritional management strategies and to explore a suitable nutritional intervention program for this population.

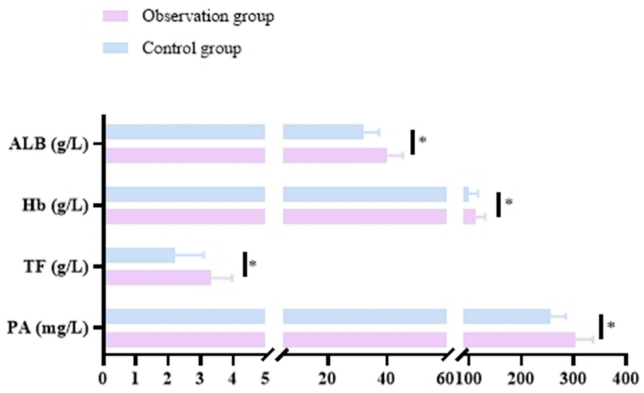

Figure 4 Comparison of Nutritional Improvement Indicators Between the Two Groups.
Note: * indicates a statistically significant difference, P < 0.05.

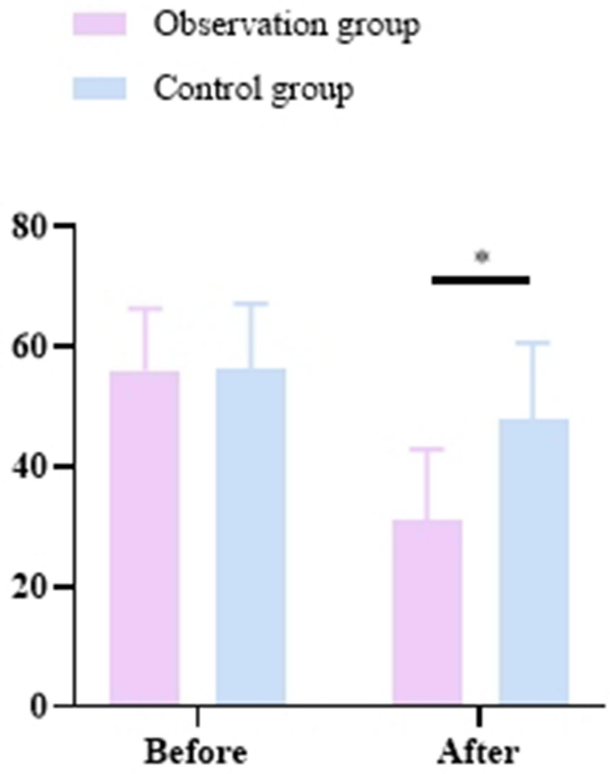

Figure 5 Comparison of MLHFQ Scores Between the Two Groups.
Note: * indicates a statistically significant difference, P < 0.05.

Nutritional Status of CHF Patients

First, dietary structure refers to the types, quantities, and proportions of foods in a diet. In recent years, there has been a significant change in dietary patterns in China: the intake of meat and fats has increased, while the consumption of grains has decreased, and salt intake has consistently exceeded recommended levels. Research indicates that dietary structure is closely related to the onset and progression of cardiovascular diseases, and thus, adjusting the dietary structure is crucial for the prevention and treatment of these diseases. The results of this study show that the dietary intake of CHF patients is broadly consistent with the changing trends in China's dietary structure. It was also found that

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salt intake among CHF patients is generally above recommended levels, reflecting ongoing difficulties in implementing a low-salt diet. For a long time, a low-salt diet has been considered a cornerstone of non-pharmacological treatment for CHF and has been shown to significantly improve clinical symptoms and quality of life.[21] However, the fact that CHF patients' salt intake clearly exceeds the recommended standard can be attributed to a preference for high-salt foods. This preference may be biologically linked to food addiction, making it difficult to change dietary habits through verbal education alone.

Regarding nutritional status, this study found significant differences in the nutritional conditions of CHF patients. Of the 100 patients, 27.00% had a normal nutritional status (MNA-HF $\geq$ 22), 42.00% were at nutritional risk (MNA-HF between 16 and 22), and 31.00% were malnourished (MNA-HF < 16). This finding is consistent with previous studies, further confirming the high risk of malnutrition among CHF patients. The damage to cardiac function in heart failure patients leads to changes in hemodynamics, which in turn affect gastrointestinal absorption, increasing the risk of malnutrition.[22,23] Furthermore, these patients often experience symptoms such as loss of appetite, indigestion, and weight loss, which exacerbate the nutritional issues. Research also indicates that the total energy expenditure and catabolic hormone levels in CHF patients are higher than those of healthy individuals, necessitating more energy and protein to maintain energy and nitrogen balance in the body.[24,25] However, this study found that the energy intake and intake of various nutrients among CHF patients were generally lower than the provincial average, further highlighting the issue of inadequate energy and nutrient intake in these patients' daily diets. These issues not only affect their nutritional status but may also worsen their heart failure symptoms, leading to disease progression. Therefore, effective interventions targeting the dietary structure and nutrient intake of CHF patients, especially providing sufficient energy and high-quality protein, are crucial for improving their overall health status.

In summary, dietary structure and nutritional intervention play an essential role in the management of chronic heart failure. The study results suggest the need for more effective dietary guidance and interventions, particularly in salt intake and energy supplementation, to further optimize the dietary structure of CHF patients and improve their nutritional status and quality of life.

In brief, dietary structure and nutritional intervention play a crucial role in the management of chronic heart failure (CHF). The results of this study suggest that more effective dietary guidance and interventions are needed, particularly in terms of salt intake and energy supplementation, to further optimize the dietary structure of CHF patients and improve their nutritional status and quality of life.

The Effect of the Transtheoretical Model-Based Stepwise Graded Nutritional Management Program on the Improvement of CHF Patients

This study utilized a stepwise graded nutritional management program based on the Transtheoretical Model (TTM). The TTM is a comprehensive behavior change theory widely applied in health behavior interventions. According to TTM, behavior change is a dynamic, staged process, which can be divided into several phases such as preparation, action, and maintenance.[26–28] By designing targeted interventions based on the patient's current stage of behavior change, the success rate of behavior modification can be significantly improved. In recent years, the application of TTM in chronic disease management has been increasing, but its use in the nutritional intervention of CHF patients remains in the exploratory stage.

This program evaluates both the nutritional status and the willingness of patients to change their behaviors. Through dynamic adjustments to intervention measures, it aims to achieve precise and personalized nutritional support. Compared with traditional nutritional management approaches, stepwise graded management not only focuses on the physiological state of the patient but also emphasizes psychological and behavioral interventions, aiming to improve patient compliance and intervention effectiveness. The program is tailored to the patient's actual needs and the changes in their condition, implementing personalized nutritional interventions with good results.

The advantage of stepwise graded management lies in its flexibility and specificity. For patients with good nutritional status, basic nutritional support and health education can be provided. For those who are malnourished or at nutritional risk, closer monitoring and management are required, with high-energy, high-protein nutritional support and personalized

adjustments based on the patient's acceptance and needs. Additionally, regular nutritional assessments and follow-ups can help identify potential nutritional risks early and take appropriate intervention measures to prevent the worsening of malnutrition.

CHF patients often experience limited digestive and absorption function due to gastrointestinal and hepatic congestion, leading to reduced appetite. Over time, this can cause malnutrition, which in turn prolongs the disease and increases the risk of mortality. Therefore, developing a personalized nutritional management plan based on the patient's specific condition, dietary preferences, and nutritional status is key to improving their health. Nutritional management should not only focus on supplementing nutrients but also on regulating blood pressure, blood lipids, and blood glucose levels, as well as eliminating cardiovascular risk factors to help patients develop healthy eating habits.[29–31]

The results of this study show that after intervention, there were no significant differences in HDL-C and LDL-C levels between the two groups ($P > 0.05$), but the serum levels of total cholesterol (TC) and triglycerides (TG) were significantly lower in the intervention group compared to the control group. Blood lipids consist of both exogenous and endogenous lipids, with TG primarily coming from food and TC partially derived from food, making them more influenced by diet. Elderly CHF patients who have long-term malnutrition or nutritional risk often require prolonged use of lipid-lowering medications due to the chronic nature of their condition, resulting in relatively stable endogenous blood lipid levels.[32,33] The reduction in TC and TG levels in the intervention group can be directly attributed to the dietary adjustments and nutritional support provided in the stepwise graded nutritional management program. By controlling the intake of high-fat foods and providing appropriate energy and protein sources, the program effectively regulated the exogenous lipid intake, leading to the observed decrease in TC and TG.

In addition, the study also found that nutritional intervention had a significant positive impact on the quality of life of patients with chronic heart failure (CHF). Using the Minnesota Living with Heart Failure Questionnaire (MLHFQ) to assess changes before and after the intervention, the results showed that the quality of life of patients significantly improved after the intervention, especially in terms of physical limitations and emotional status. The improvement in physical limitations can be linked to the enhanced physical strength and improved nutritional status resulting from the intervention. With proper energy and nutrient supplementation, patients' physical functions were enhanced, allowing them to engage in more daily activities. Regarding the improvement in emotional status, the psychological interventions integrated into the TTM-based program, such as regular psychological assessments, group discussions, and emotional care, played a crucial role. These interventions helped patients better cope with the stress and anxiety associated with CHF, thus improving their emotional well-being.

Since there is currently no cure for chronic heart failure (CHF), although standardized clinical treatments can effectively control the condition, patients often face repeated exacerbations, which not only affect their physical health but also severely impact their mental state. The recurring nature of the condition can easily trigger negative emotions, such as anxiety and pessimism, and may even lead to thoughts of giving up treatment. Long-term mental stress and emotional disturbances can lead to an imbalance between excitation and inhibition processes in the cerebral cortex, negatively affecting the patient's recovery.[34,35] Therefore, patients' psychological health issues should not be ignored. This study specifically emphasized the important role of psychological interventions in the nutritional management of CHF patients. Research has shown that patients with CHF often experience psychological issues such as anxiety and depression, which not only affect their quality of life but may also reduce their adherence to nutritional interventions, thus impacting the effectiveness of the intervention. By regularly conducting psychological assessments and monitoring patients' emotional status using the Self-Rating Anxiety Scale (SAS) and the Self-Rating Depression Scale (SDS), psychological issues can be detected and adjusted in a timely manner. Furthermore, encouraging patients to participate in group discussions, emotional care, and communication and support from nursing staff and family members can effectively alleviate anxiety, strengthen their confidence in recovery, and improve the effectiveness of nutritional interventions.[36–38] In summary, psychological intervention not only helps improve the emotional status of CHF patients but also enhances their enthusiasm for treatment and nutritional interventions, thereby promoting the recovery process. Therefore, psychological health management should become an integral part of comprehensive treatment for CHF patients.

Although this study provides insight into the application of a stepwise graded nutritional management program based on the Transtheoretical Model for CHF patients, there are still certain limitations. The study has several limitations that should be addressed in future research. The small sample size (n=100) and single-region design limit the generalizability of the findings, suggesting that future studies should aim to include a larger and more diverse population through multi-

center approaches. Additionally, the short duration of the intervention may not capture long-term effects on nutritional status and clinical outcomes, highlighting the need for longer follow-up periods to assess the sustainability of the intervention. Potential biases, such as selection bias from recruiting participants at a single center and the lack of a randomized control group, may have influenced the results. Therefore, randomized controlled trials should be considered to strengthen the validity of the findings. Finally, while the study demonstrated improvements in biomarkers and quality of life, the underlying biological and psychological mechanisms driving these changes were not fully explored, and future research should investigate these pathways to better understand the intervention's impact.

Conclusion

Overall, the dietary structure of patients with chronic heart failure (CHF) is inadequate, and their nutritional status is generally poor. This study validates the effectiveness of the Transtheoretical Model (TTM)-based stepwise graded nutritional management program for CHF patients, demonstrating its potential to improve nutritional status, enhance quality of life, and positively influence psychological well-being. The structured, stage-tailored approach of this intervention makes it particularly suitable for integration into standardized CHF care pathways, as its modular design allows for adaptation across diverse healthcare settings, including primary care clinics and tertiary hospitals.

While short-term outcomes are promising, future implementation should prioritize longitudinal studies to evaluate the program's sustained impact on critical endpoints such as hospital readmission rates, cardiovascular mortality, and long-term functional capacity. Further research could also explore its applicability to underserved populations, patients with comorbidities, and its synergies with emerging digital health technologies for remote monitoring.

It is important to acknowledge this study's limitations, including its single-center design, relatively small sample size, and short follow-up period. Nonetheless, these findings provide a robust foundation for scaling this intervention. With continued optimization and validation, the TTM-based nutritional management program holds significant potential to deliver personalized, precision care for CHF patients, ultimately improving both clinical outcomes and holistic patient well-being.

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