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*Original Article*

# Effect of trimodal pre-rehabilitation on the rehabilitation of patients with gastrointestinal tumors in the perioperative period

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**Abstract:** Objective: To explore the effects of trimodal pre-rehabilitation on the rehabilitation of patients with gastrointestinal tumors in the perioperative period. Methods: Clinical data of 878 patients with gastrointestinal tumors undergoing surgical treatment in our hospital were analyzed in this retrospective study. They were divided into a control group and an observation group. The patients in the control group received only routine preoperative education and guidance before operation, while those in the observation group received preoperative trimodal pre-rehabilitation. The nutritional status, sleep quality, psychological status, and physical function of two groups were compared 1 day before operation and at discharge. The postoperative complications, length of hospital stays, and hospitalization expenses were compared. The patients were followed up for three months after discharge from the hospital, and the quality of life between groups was compared. Results: The nutritional status of two groups 1 day before operation and at discharge was improved compared with that at admission (all P<0.001). The nutritional status in the observation group was better than that in the control group 1 day before operation. The scores of sleep quality, psychological status, and physical function of the observation group were higher than those in the control group 1 day before surgery and at discharge (all P<0.001). The observation group had shorter hospital stays and lower hospitalization expenses than the control group (all P<0.001). The 3-month follow-up after discharge showed that the observation group had higher quality of life than the control group (all P<0.05). Conclusion: Trimodal pre-rehabilitation can improve the preoperative nutritional status, sleep quality, psychological state, and physical function of patients with gastrointestinal tumors during the perioperative period. Besides, it can shorten the hospital stays, reduce the total hospitalization expenses, and improve the quality of life of patients after discharge. It is worthy of clinical promotion.

**Keywords:** Pre-rehabilitation, gastrointestinal tumors, perioperative period, rehabilitation

## Introduction

Gastrointestinal tumor, a common malignant tumor, ranks top 5 in the incidence in China [1]. Surgery is still one of the effective treatments [2]. However, the huge trauma and various postoperative complications caused by the operation negatively affect the patient's recovery and prognosis [3]. In China, aging society is becoming more evident, and elderly cancer patients are more likely to have various problems after operation due to the decline of their organ functions [4]. Therefore, growing clinical attention has been paid to the postoperative rehabilitation of patients with gastrointestinal surgery.

At present, traditional rehabilitation of patients with intestinal tumors focuses on improving or strengthening interventions after surgery [5]. In recent years, it has proved that insufficient physical nutrition before surgery increases the incidence of postoperative complications [6]. At the same time, increasing studies turn out that good preoperative preparations are beneficial to reduce postoperative complications and promote postoperative recovery [7, 8]. On this basis, the concept of pre-rehabilitation is proposed. Pre-rehabilitation refers to the process of assessing, identifying the degree and risk of impairment of a patient's basic function through physical and psychological means and providing targeted interventions to improve the

patient's health and reduce the incidence and severity of possible damage at present and in future, including pre-operative exercise, nutritional support and psychological pre-rehabilitation [9]. It includes preoperative exercise pre-rehabilitation (e.g., walking training, cardiopulmonary exercise), nutritional support pre-rehabilitation (e.g., professional nutrition assessment to develop personalized nutrition support programs) and psychological pre-rehabilitation (e.g., psychological guidance, music therapy) [10]. Thus, it is called trimodal pre-rehabilitation, which has now been widely used in various pre-operative preparations covering abdominal surgery and has achieved good results [11, 12].

However, the current research generally believes that 2-4 weeks' pre-rehabilitation is the suitable intervention time [13, 14]. Obviously, it is difficult to adapt to the current hospitalization requirements in China, which limits the application of trimodal pre-rehabilitation. In addition, there is still a lack of standards and conclusions regarding the specific implementation plans and models of pre-rehabilitation. There is also some controversy as to whether short-term (less than 2 weeks) pre-rehabilitation interventions can have a positive effect on surgical patients [15]. Therefore, the effect of short-term pre-rehabilitation urgently needs to be explored and confirmed by large-scale clinical research. If an efficient short-term pre-rehabilitation can be supplemented in patients with gastrointestinal surgery, it will have obvious clinical value and significance.

This study aimed to explore the effect of short-term trimodal pre-rehabilitation on the rehabilitation of patients with gastrointestinal tumors in the perioperative recovery based on existing research.

## Materials and methods

### *General data and grouping*

This retrospective study was approved by the Ethics Committee of the Ninghai First Hospital (approval No. nhyy-ICE-LW-2021018). A total of 878 patients with gastrointestinal tumors undergoing surgical treatment in the Ninghai First Hospital from June 2018 to March 2021 were selected, and their clinical data were analyzed. Among them, 346 cases had gastric cancer and 532 cases suffered from colorectal cancer. They were divided into a control group and an observation group, with 439 cases each. The patients in the control group received only routine preoperative education and guidance before operation, while those in the observation group received preoperative trimodal pre-rehabilitation.

*Inclusion criteria:* (1) Patients aged from 18 to 80 years. (2) Patients' diagnosis met the standard of *Diagnostic Criteria for Primary Gastric Cancer, Rectal Cancer and Colon Cancer* [16, 17]. (3) Patients were performed with selective radical resection of gastric cancer or rectal cancer. (4) Patients had complete medical records. (5) Patients knew about the study and signed an informed consent.

*Exclusion criteria:* (1) Patients had concurrent infection. (2) Patients had mental illness and cognitive impairment. (3) Patients were combined with severe malnutrition, and organ dysfunction. (4) Patients were combined with other malignant tumors outside the gastrointestinal tract. (5) Patients were expected to have a survival time less than 3 months. (6) Patients had motor dysfunction or decreased muscle strength due to various reasons (myasthenia gravis, fractures, arthritis, etc.).

### *Data collection*

Patient data were observed and collected, including age, gender, body mass index, comorbidities (hypertension, diabetes, hyperlipidemia), smoking, drinking, family history of gastric/colorectal cancer, gastric/colon cancer staging, nutritional status, sleep quality, psychological status, physical function, etc. [18].

TNM staging system was used for grading of gastric cancers. T stage reflects the size of tumors. Lymph node (N) stage is defined by location of lymph node metastases. M stage is usually used to characterize distant metastases.

### *Methods*

With reference to the existing research, patients in the control group adopted conventional preoperative education and preparations [19-21]. Specific measures included hospital routine education upon admission (introduction of medical care, rules and regulations, use

of equipment, disease conditions, surgical content, etc.), preoperative precautions (no food, no water, skin preparation for surgical area, etc.), precautions of preoperative intestinal preparation (use of intestinal drugs, determination of adequate intestinal preparation, etc.), possible complications and precautions after surgery.

Patients in the observation group received trimodal pre-rehabilitation measures on the basis of the methods used in the control group. A pre-rehabilitation team was set up. One chief physician was responsible for preoperative evaluation, set-up and adjustment of pre-rehabilitation programs. One case manager was in charge of the follow-up and the establishment of relevant files of discharged patients. One chronic disease manager, who had the same working hours with the outpatient time of the chief physician, mainly took charge of follow-up after outpatient clinic, health education, and timely feedback to the director. Nursing staff in the whole center received training on pre-rehabilitation, containing pre-operative pre-rehabilitation evaluation, pre-operative support, sports training, and perioperative psychological nursing knowledge. The staff had to pass the assessment first. They should personalize guidance for patients' pre-rehabilitation, supervise and record perioperative nutrition and exercise intervention measures, record and give timely feedback on patients' nutrition and training implementation.

Trimodal pre-rehabilitation consisted of sports intervention, nutritional intervention and psychological intervention, which should be finished 7-10 days before surgery [22].

Patients received exercise pre-rehabilitation, covering walking training, grip training, stair climbing exercises and cardiopulmonary exercises.

The pre-evaluation of nutrition for patients was realized by nutritional risk screening (NRS 2002 score) scale [23]. It was recommended to consume 1.2 g/kg protein per day (Reineng 2 bottles/day) for patients with NRS 2002 scores ≥3.

In NRS (2002) scores, 3 points (severe) are considered as loss of weight in 1 month (loss of 15% of weight in 3 months) or BMI <18.5 or 0% to 25% of normal requirements of food intake during the previous week.

Psychological intervention comprised breathing relaxation training, personalized music therapy and assisted sleep, which should be completed 7-10 days before surgery.

*Outcome measures*

Main outcome measures were made of the nutritional status, sleep quality, psychological status, and physical function of the two groups at admission, 1 day before operation and at discharge. The postoperative complications, hospital stays and hospitalization expenses between groups were compared.

Three-month follow up of patients after being discharged from the hospital, and the quality of life in the two groups were set as secondary outcome measures.

*Evaluation indicators*

The prealbumin and albumin levels were used to evaluate the patients' nutritional status. Peripheral venous blood was collected on an empty stomach the day after admission, 1 day before surgery, and on the morning of discharge to determine nutritional status.

Pittsburgh sleep quality index (PSQI) was adopted to assess sleep quality [24]. It contains 23 questions with 18 self-rated questions. The lower the score is, the better the quality of sleep would be.

Self-rating depression scale (SDS) and self-rating anxiety scale (SAS) were used to assess psychological status [25]. SAS scores >50 suggests anxiety, and SDS scores ≥53 indicates depression. The lower the scores of SAS and SDS, the better the mental state.

Six-minute walking test and non-idiomatic grip strength were adopted for the evaluation of physical function [26, 27]. The longer 6-minute walking distances and the greater non-idiomatic grip strength revealed the better physical function.

The 36-Item Short Form Survey (SF-36) was used as a measure of health-related quality of life [28]. It is composed of general health, vitality, emotional role functioning, social role functioning, and physical functioning. The higher scores demonstrate better quality of life.

**Table 1.** Comparison of general data (n/%, $\bar{x}$±sd)

| Items | Control group | Observation group | $\chi^2$/t | P |
|---|---|---|---|---|
| Case (n) | 439 | 439 | | |
| Gastric/colorectal cancer | 165/274 | 181/258 | 1.221 | 0.269 |
| Gender (male/female, case) | 242/197 | 255/184 | 0.784 | 0.376 |
| Age (years old) | 61.6±7.3 | 61.2±6.9 | 0.834 | 0.404 |
| Body mass index (kg/m$^2$) | 22.57±2.54 | 22.42±2.58 | 0.868 | 0.386 |
| Comorbidities | | | | |
| Hypertension (n) | 178 | 192 | 0.916 | 0.339 |
| Diabetes (n) | 135 | 157 | 2.483 | 0.115 |
| Hyperlipidemia (n) | 111 | 129 | 1.858 | 0.173 |
| Smoking (n) | 208 | 232 | 2.624 | 0.105 |
| Drinking (n) | 285 | 297 | 0.734 | 0.392 |
| Family history of gastric cancer (n) | 120 | 109 | 0.715 | 0.398 |
| Family history of colorectal cancer (n) | 198 | 173 | 2.917 | 0.088 |
| Gastric cancer staging | | | | |
| 0 | 15 | 18 | | |
| I | 53 | 49 | 1.119 | 0.772 |
| II | 64 | 77 | | |
| III | 33 | 37 | | |
| Colon cancer staging | | | | |
| 0 | 17 | 16 | | |
| I | 85 | 80 | 0.011 | 1.000 |
| II | 102 | 97 | | |
| III | 70 | 65 | | |

Note: $\chi^2$, statistic value from chi-square test; t, statistic value from t-test.

The occurrence of postoperative pulmonary infection and anastomotic leakage were used as the evaluation criteria for postoperative complications.

*Statistical analysis*

SPSS 26.0 software was used for the statistical analyses. Measurement data were expressed as mean ± standard deviation ($\bar{x}$±sd). Independent t test was carried out for comparison between groups. Comparison of data before and after treatment within the group was performed using paired-sample t test. Count data were expressed by number/percentage (n/%), and compared by the chi-square test. P<0.05 meant that the results were statistically different among groups.

## Results

*Comparison of general data*

No differences were observed in terms of cases of gastric/colorectal cancer, age, gender, body mass index, comorbidities (hypertension, diabetes, and hyperlipidemia), smoking, drinking, family history of gastric/colorectal cancer and gastric/colon cancer staging between the two groups (all P>0.05). See **Table 1**.

*Comparison of nutritional status before and after operation*

There were no differences in prealbumin and albumin levels between the two groups on admission (both P>0.05). The prealbumin and albumin levels of the two groups were significantly increased 1 day before operation, and the observation group had higher levels than those of the control group (both P<0.001). The above two levels in both groups at discharge were significantly higher than those on admission (both P<0.001), but without significant difference between the groups (P>0.05). See **Table 2** and **Figure 1**.

*Comparison of sleep quality before and after operation*

There was no difference in sleep quality scores between the groups on admission (all P>0.05). No significant change was observed in the

**Table 2.** Comparison of nutritional status before and after operation

| Group | Time | Prealbumin levels (g/L) | albumin levels (g/L) |
|---|---|---|---|
| Control group (n=439) | On admission | 212.42±4.23 | 36.86±0.41 |
| | 1 day before operation | 215.45±3.98*** | 38.24±0.35*** |
| | At discharge | 217.98±4.18*** | 38.99±0.38*** |
| Observation group (n=439) | On admission | 212.52±4.18 | 36.75±0.45 |
| | 1 day before operation | 216.76±4.33***,### | 38.92±0.46***,### |
| | At discharge | 218.47±4.38*** | 39.04±0.39*** |

Note: Comparison with the levels on admission in the same group, ***P<0.001; Comparison with the control group, ###P<0.001.

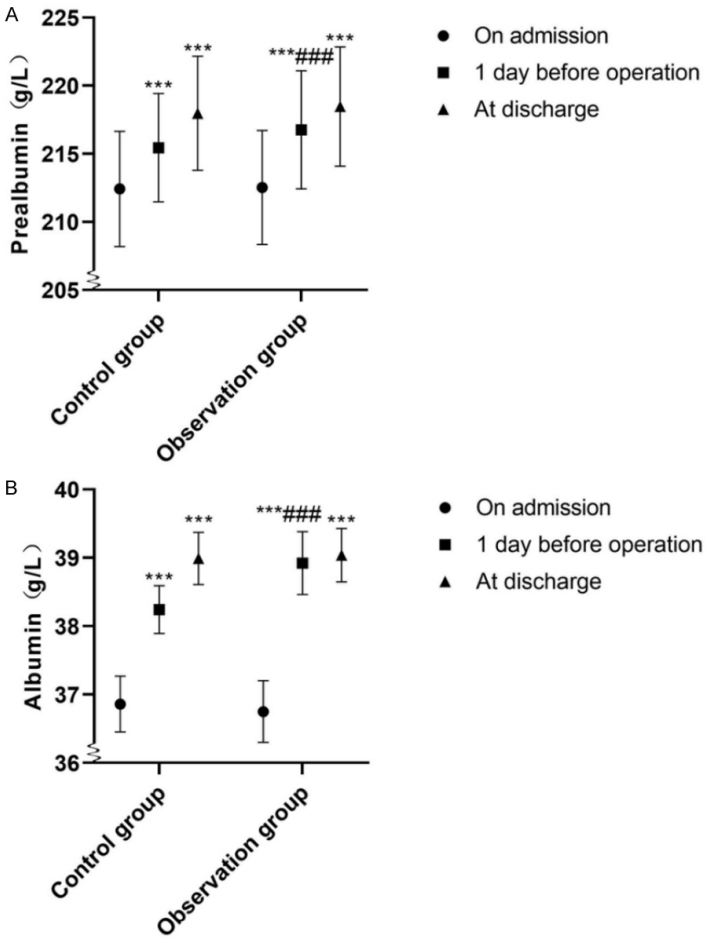


**Figure 1.** Comparison of nutritional status before and after operation. A: Comparison of prealbumin levels before and after operation; B: Comparison of albumin levels before and after operation. Comparison with the levels on admission in the same group, ***P<0.001; comparison with the control group, ###P<0.001.

sleep quality scores of the control group 1 day before operation (all P>0.05). The sleep quality scores of patients in the observation group were decreased significantly and were remarkably lower than those in the control group (all P<0.001). At discharge, patients in the control group had no change in the sleep quality scores as compared with those at admission (all P>0.05), while those in the observation group were obviously lower than those of the control group and at admission (all P< 0.001). See **Table 3** and **Figure 2A-D**.

*Comparison of psychological status before and after operation*

There were no differences in SDS and SAS scores between the groups on admission (both P>0.05). No change was found in SDS and SAS scores in the control group 1 day before operation (both P>0.05). SDS and SAS scores of the observation group were decreased significantly and were significantly lower than those of the control group (all P<0.001). At discharge, SDS and SAS scores of the control group remained unchanged (both P>0.05). The above indexes in the observation group were significantly lower than those at admission and in the control group (all P< 0.001). See **Table 4** and **Figure 3A**, **3B**.

*Comparison of physical function before and after operation*

No differences were found in 6-minute walking test and non-dominant grip strength (both P>0.05) between the two groups at admission. There was no change in the 6-minute walking test and non-dominant grip strength of the control group 1 day before the operation (both P> 0.05). However, the 6-minute walking test and non-dominant grip strength in the observation group were significantly increased

**Table 3.** Comparison of sleep quality before and after operation ($\bar{x}\pm sd$)

| Group | Time | Scores of falling asleep time | Scores of sleep time | Scores of sleep efficiency | Scores of sleep disorder |
|---|---|---|---|---|---|
| Control group (n=439) | On admission | 3.4±0.3 | 2.7±0.4 | 2.3±0.6 | 2.4±0.4 |
| | 1 day before operation | 3.4±0.5 | 2.7±0.4 | 2.3±0.5 | 2.4±0.2 |
| | At discharge | 3.3±0.5 | 2.6±0.8 | 2.2±0.9 | 2.3±0.8 |
| Observation group (n=439) | On admission | 3.4±0.3 | 2.7±0.3 | 2.3±0.4 | 2.4±0.5 |
| | 1 day before operation | 3.1±0.4$^{***,\#\#\#}$ | 2.5±0.4$^{***,\#\#\#}$ | 2.2±0.5$^{***,\#\#\#}$ | 2.3±0.6$^{***,\#\#\#}$ |
| | At discharge | 3.1±0.2$^{***,\#\#\#}$ | 2.4±0.3$^{***,\#\#\#}$ | 2.1±0.4$^{***,\#\#\#}$ | 2.2±0.5$^{***,\#\#\#}$ |

Note: Comparison with the scores on admission in the same group, $^{***}$P<0.001; comparison with the control group, $^{\#\#\#}$P<0.001.

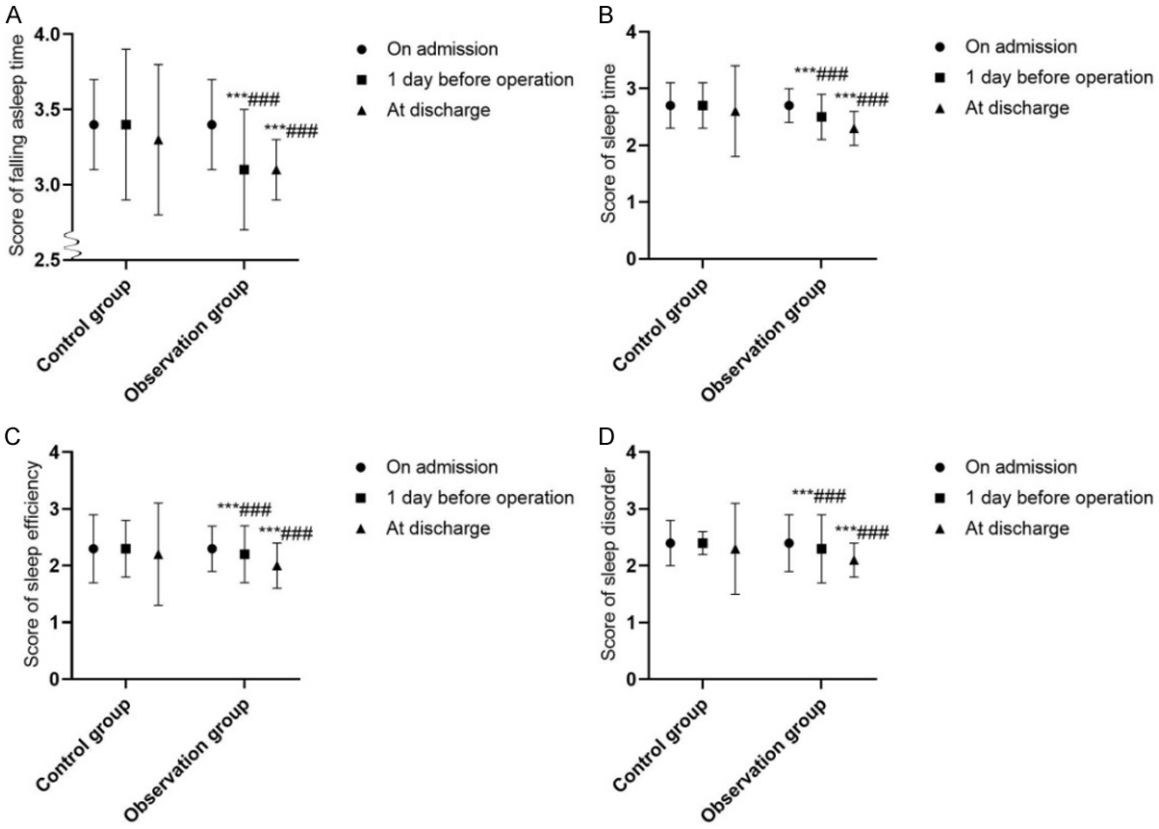


**Figure 2.** Comparison of sleep quality before and after operation. A: Comparison of the scores of falling asleep time to; B: Comparison of the scores of sleep time; C: Comparison of the scores of sleep efficiency; D: Comparison of the scores of sleep disorder. Comparison with the scores on admission in the same group, $^{***}$P<0.001; comparison with the control group, $^{\#\#\#}$P<0.001.

and obviously higher than those in the control group (all P<0.001). At discharge, no change in the above indicators was found in the control group (both P>0.05). The 6-minute walking test and non-dominant grip strength in the observation group were significantly higher than those at admission and those in the control group (both P<0.001). See **Table 5** and **Figure 4**.

*Comparison of postoperative complications, hospital stays and hospitalization expenses*

There was no difference in postoperative complications between the two groups (all P>0.05). The observation group had shorter hospital stays and lower total hospitalization expenses than the control group (both P<0.001). See **Table 6**.

**Table 4.** Comparison of psychological status before and after operation ($\bar{x}$±sd)

| Group | Time | SDS scores | SAS scores |
|---|---|---|---|
| Control group (n=439) | On admission | 49.2±3.0 | 50.4±4.2 |
| | 1 day before operation | 49.1±3.2 | 50.4±4.0 |
| | At discharge | 48.2±3.5 | 49.8±4.6 |
| Observation group (n=439) | On admission | 49.1±3.1 | 50.2±4.3 |
| | 1 day before operation | 47.9±3.0***,### | 47.6±4.5***,### |
| | At discharge | 45.2±3.3***,### | 46.3±4.4***,### |

Note: Comparison with the scores on admission in the same group, ***P<0.001; Comparison with the control group, ###P<0.001. SDS, self-rating depression scale; SAS, self-rating anxiety scale.

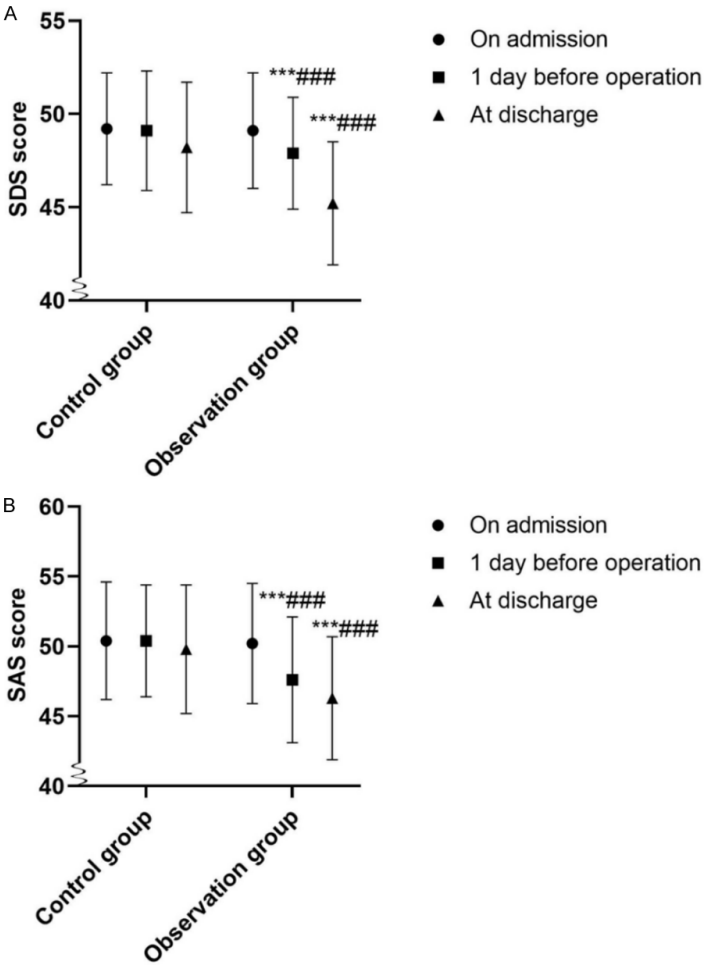


**Figure 3.** Comparison of psychological status before and after operation. A: Comparison of SDS scores; B: Comparison of SAS scores. Comparison with the scores on admission in the same group, ***P<0.001; comparison with the control group, ###P<0.001. SDS, self-rating depression scale; SAS, self-rating anxiety scale.

*Comparison of the quality-of-life scores 3 months after discharge*

There was no difference in the quality of life scores between the groups (P>0.05) at admission. Three months after the patients were discharged from the hospital, the scores related to the quality of life of the two groups were increased (all P<0.05). The observation group had significantly higher quality-of-life scores than the control group (all P<0.001). See **Table 7** and **Figure 5**.

## Discussion

Pre-rehabilitation strategies used in a variety of surgeries have been verified to benefit patients [29-31]. However, it is not clear whether short-term (less than 2 weeks) pre-rehabilitation can achieve the same effects. In recent years, research on the effects of short-term pre-rehabilitation has continued to develop. Studies have shown that short-term pre-rehabilitation strategies applied to patients with esophageal cancer during the perioperative period can improve nutritional status, postoperative bowel function and reduce complications [32].

In this study, there was no difference in nutritional status between the two groups on admission. One day before surgery, the nutritional statuses of the two groups were improved, and the improvement in the observation group was more significant. Studies have shown that 10-14 days' nutritional interventions prior to surgery can improve the nutritional conditions of patients with gastrointestinal tumor surgery, shorten hospital stays and reduce hospitalization costs, which finding is consistent

**Table 5.** Comparison of physical function before and after operation ($\bar{x}$±sd)

| Group | Time | 6-minute walking test (m) | Non-dominant grip strength (kg/m$^2$) |
|---|---|---|---|
| Control group (n=439) | On admission | 550±52 | 35.25±9.24 |
| | 1 day before operation | 551±56 | 35.45±9.56 |
| | At discharge | 552±59 | 35.33±9.87 |
| Observation group (n=439) | On admission | 548±48 | 35.12±9.18 |
| | 1 day before operation | 560±55***,### | 37.25±9.45***,### |
| | At discharge | 564±58***,### | 37.33±9.68***,### |

Note: Comparison with on admission in the same group, ***P<0.001; Comparison with the control group, ###P<0.001.

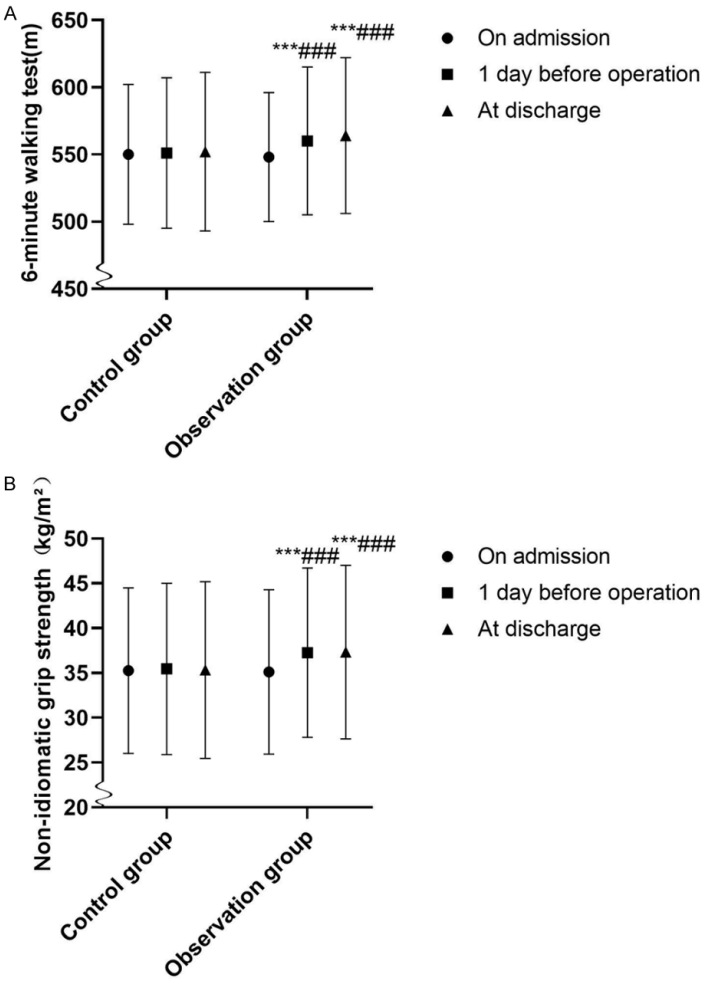


**Figure 4.** Comparison of physical function before and after operation. A: Comparison of 6-minute walking test; B: Comparison of non-dominant grip strength. Comparison with the score on admission in the same group, ***P<0.001; comparison with the control group, ###P<0.001.

with the results of this study [19]. This may be because the patients in the observation group received nutritional status assessment before surgery and were given a preoperative intensive nutritional support program based on the assessment results.

In this study, there was no difference in sleep quality scores and psychological status scores between the two groups on admission. Through pre-rehabilitation intervention, compared with the control group, the mentioned scores of the observation group were significantly improved 1 day before operation and at discharge. It is reported that psychological intervention can help improve the psychological status and sleep quality of cancer patients [33]. The results of this study were consistent with that. The rationale may be that during the pre-rehabilitation process, patients in the observation group received psychological interventions including psychological relaxation and sleep assistance, so their negative conditions such as anxiety and depression were reduced, and their sleep quality was improved.

In this study, no difference in the physical function was found in the two groups when they were admitted to the hospital. Through pre-rehabilitation intervention, the observation group had significantly increased physical function than the control group one day before operation and at discharge, suggesting that pre-rehabilitation improved the physical function of patients undergoing gastrointestinal tumor surgery.

**Table 6.** Comparison of postoperative complications, hospital stays and hospitalization expenses

| Item | Control group | Observation group | $\chi^2$/t | P |
|---|---|---|---|---|
| Case (n) | 439 | 439 | | |
| Pulmonary infection (n, %) | 17 (3.87) | 15 (3.42) | 0.130 | 0.719 |
| Anastomotic leakage (n, %) | 16 (3.64) | 12 (2.73) | 0.590 | 0.442 |
| Hospital stays (d) | 10.05±3.21 | 8.63±3.69 | 6.083 | <0.001 |
| Hospitalization expenses (yuan) | 66796.2±10253.6 | 59543.8±10289.4 | 10.460 | <0.001 |

Note: $\chi^2$, statistic value from chi-square test; t, statistic value from t-test.

**Table 7.** Comparison of the quality-of-life scores 3 months after discharge

| Group | Body function scores | Social function scores | Emotion scores | Vigor scores | Overall health scores |
|---|---|---|---|---|---|
| Control group (n=439) | | | | | |
| On admission | 52.34±2.84 | 50.68±4.51 | 61.22±2.61 | 44.57±4.52 | 65.28±4.82 |
| 3 months after discharge | 52.74±2.88* | 51.42±4.38* | 61.58±2.54* | 45.32±4.83* | 66.12±4.84* |
| Observation group (n=439) | | | | | |
| On admission | 52.62±2.82 | 50.64±4.71 | 61.29±2.57 | 44.43±4.34 | 65.18±4.78 |
| 3 months after discharge | 54.72±2.56***,### | 52.79±4.63***,### | 62.39±2.63***,### | 46.35±4.23***,### | 67.21±4.73***,### |

Note: Comparison with the scores on admission in the same group, *P<0.05, ***P<0.001; comparison with the control group, ###P<0.001.

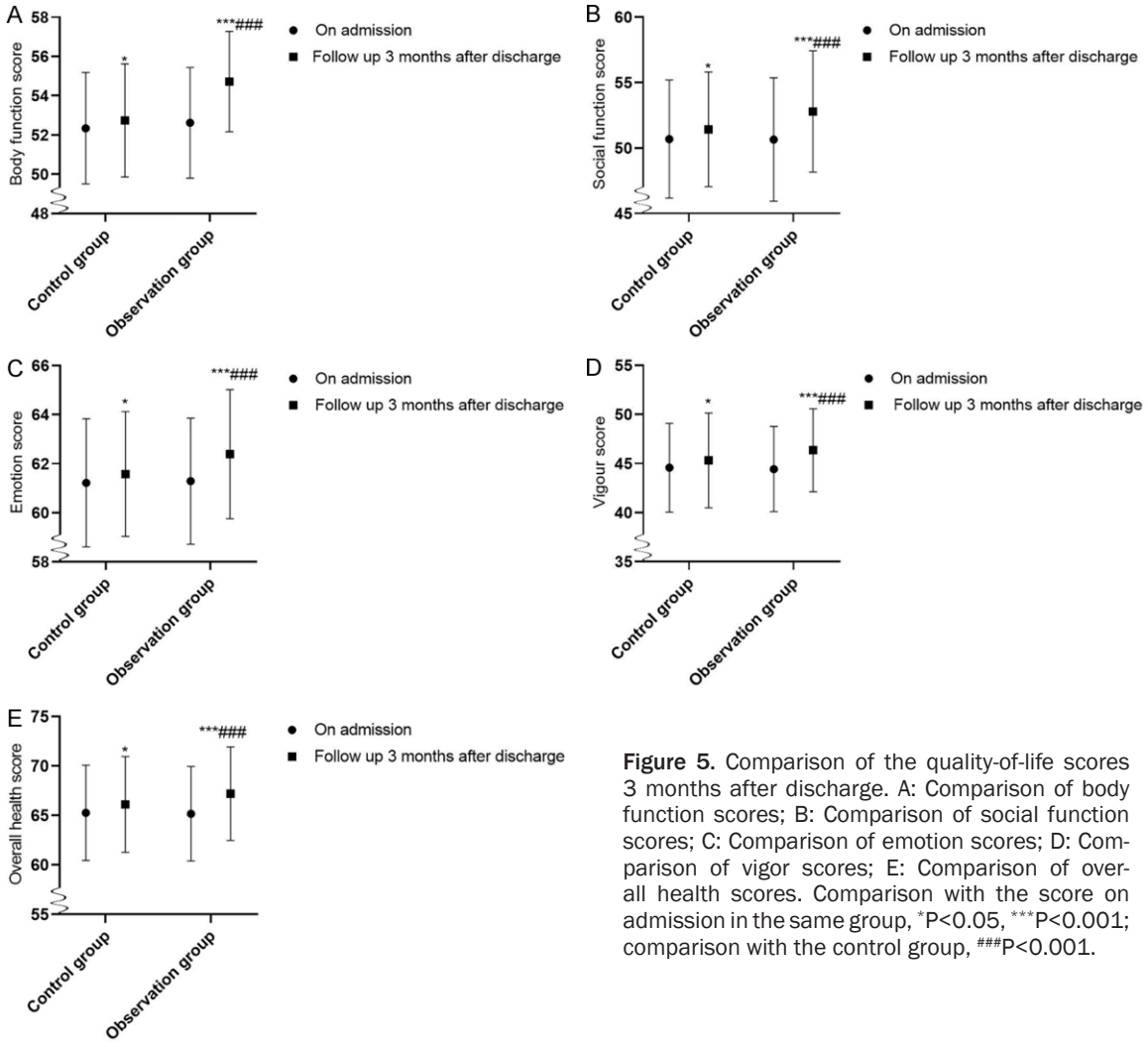


**Figure 5.** Comparison of the quality-of-life scores 3 months after discharge. A: Comparison of body function scores; B: Comparison of social function scores; C: Comparison of emotion scores; D: Comparison of vigor scores; E: Comparison of overall health scores. Comparison with the score on admission in the same group, *P<0.05, ***P<0.001; comparison with the control group, ###P<0.001.

In this study, patients in the observation group received pre-rehabilitation interventions before surgery, including targeted nutritional support and exercise training (walking, climbing stairs, and cardiopulmonary exercises). It has proved that preoperative nutrition and exercise not only improve the physical function, but also reduce postoperative complications and improve the prognosis of patients after surgery [34-36]. The latest research turns out that short-term pre-rehabilitation can improve the preoperative physical function of patients with colorectal cancer, which is consistent with the results of this study [22].

In this study, the observation group had shorter postoperative hospital stays and lower hospitalization expenses. Three-month follow up of patients discharged from the hospital showed that the observation group had higher quality of life. It has been revealed that pre-rehabilitation measures reduce hospitalization expenses while improve the quality of life of patients, which is consistent with the results of this study [37, 38]. The reason may be that patients in the observation group received pre-rehabilitation interventions, and through enhanced nutritional support and exercises, the preoperative nutritional status and physical function were improved, thereby improving the tolerance of the surgery, which also accelerated the recovery of the patients after surgery, shortened the length of hospital stays and reduced the hospitalization expenses.

In this study, the nutritional status of the two groups was significantly improved at discharge as compared to the status on admission, but with no statistical difference between the groups. Although existing studies have confirmed that preoperative nutritional pre-intervention can significantly improve the nutritional status, the pre-rehabilitation measures used in this study only had a short period of time (7-10 days), which may affect the final result. At the same time, post-operative short-term fasting, post-operative natural consumption, and the reduced nutrient absorption capacity in the short-term may influence the final result as well.

It is reported that short-term pre-rehabilitation for esophageal cancer can reduce the incidence of postoperative complications [32]. However, this study didn't get the consistent outcome. The small number of cases (34 cases) may have caused the deviation.

Limited by conditions, there were still some shortcomings in this research. We failed to list the pre-rehabilitation effects of gastric cancer or colorectal cancer cases separately and could not further study whether the 10-to-14-day pre-rehabilitation course can further benefit patients either. It is worthwhile to expand the sample for further in-depth study in the later period.

To sum up, trimodal pre-rehabilitation can improve the preoperative nutritional status, sleep quality, psychological status, and physical function of patients with gastrointestinal tumors during the perioperative period. Besides, it can shorten the hospital stays, reduce the total hospitalization expenses, and improve the quality of life of patients after discharge. It is worthy of clinical promotion.

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## Disclosure of conflict of interest

None.

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