Original Article

# Gastrointestinal cancer surgery in the elderly: The effects of preoperative oral nutritional supplements - A retrospective study

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**Background and Objectives:** The current study aimed to explore the effect of nutritional prehabilitation on the clinical prognosis of elderly patients undergoing abdominal cancer surgery. **Methods and Study Design:** A retrospective study was conducted, where participants were divided into two groups based on whether they received oral nutritional supplementation at the first outpatient visit. The nutritional prehabilitation group (n=41) adopted a nutritional prehabilitation mode (a standard energy intake of 25-30 kcal/kg· d was recommended). While the control group (n=55) received routine care. All patients underwent laparoscopic surgery according to the National Comprehensive Cancer Network (NCCN) guidelines. Changes in nutritional status, complications, psychological status, symptoms, hospitalization days, and expenditures were compared between the two groups. **Results:** Both groups of patients experienced weight loss. However, the decline in body weight in the prehabilitation group was less than that in the control group (-1.88 vs. -2.56 kg, $p < 0.001$). In the comparison of nutritional prehabilitation group and control group, significant improvements were observed in the Hospital Anxiety Scale scores (5 vs. 5, $p = 0.01$) and MD Anderson Symptom Inventory scores (3 vs. 0, $p < 0.001$) respectively. The infection rate in the nutritional prehabilitation group was lower than that in the control group (17.1% vs. 36.4%, $p = 0.04$). Additionally, patients in the nutritional prehabilitation group had significantly fewer hospitalization days at discharge (14.3 vs. 17.1 days, $p = 0.03$). **Conclusions:** In elderly patients undergoing abdominal cancer surgery, a nutritional prehabilitation model may help maintain better physical and mental status, reduce infection rates, and shorten hospitalization days.

**Key Words: nutritional prehabilitation, elderly patients, abdominal cancer, psychological healthy states, clinical prognosis**

## INTRODUCTION

With the aging of the population and high incidence of cancer, there is an increasing number of elderly cancer patients requiring surgery. Advanced age is a risk factor for postoperative adverse events in elderly oncology patients.[1-4] Elderly patients tend to have weakened preoperative organ function, making them more debilitated and likely to experience postoperative complications.[5]

Postoperative complications have been reported in up to 30% of cancer patients undergoing abdominal surgery.[6] Although advanced minimally invasive and robotic techniques could reduce surgical trauma, complications cannot be entirely prevented. Enhanced Recovery After Surgery (ERAS) is an evidence-based approach to perioperative management that can reduce postoperative complications, shorten hospital stays, and lower healthcare costs.[7] However, achieving the ERAS rehabilitation goal can be

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challenging for some elderly cancer patients.

Prehabilitation is a novel concept in preoperative management that has been integrated into the application and promotion of Enhanced Recovery After Surgery (ERAS) in recent years. Focused on optimizing the utilization of community and outpatient medical resources, as well as combining preoperative exercise interventions, nutritional support, and psychological support, nutrition prehabilitation enhances the body's functional reserve to cope with surgical trauma, reduce postoperative complications, and promote recovery.[8] Although the concept of prehabilitation is still evolving and specific implementation methods and processes are not yet standardized,[9] concerns have been raised regarding its potential to delay cancer treatment and whether it could increase the risk of cancer metastasis and impair clinical prognosis.[1] However, it remains a promising strategy for surgical optimization that may benefit the clinical prognosis of elderly cancer patients.[9, 10] In this study, we investigated the impact of nutritional prehabilitation on the clinical prognosis of elderly patients undergoing abdominal cancer surgery. Our findings aim to improve health and nutritional status and enhance the quality of life in older adults.

## METHODS

### *Data collection of the study participants*

We conducted a secondary analysis based on data collected in a central retrospective study of patients undergoing gastrointestinal surgery from March 2021 to February 2022 at the General Surgery Department of the Affiliated Hospital of Xuzhou Medical University. The study was conducted in accordance with the Declaration of Helsinki (revised in 2013). Approval was obtained from the Ethics Committee of the Affiliated Hospital of Xuzhou Medical University (XYFY2022-KL040-01), and patients provided informed consent.

Patients were included in our study based on the following criteria: (i) confirmed diagnosis of gastrointestinal cancer (stomach, intestine, liver, biliary, and pancreas) according to NCCN guidelines; (ii) laparoscopic surgery performed in our general surgery department; (iii) age ≥ 60 years; (iv) Nutrition Risk Screening-2002 (NRS2002) score ≥ 3 at the first outpatient visit; (v) psychological and symptom assessments have been completed; (vi) survival period is more than six months. Exclusion criteria were: (i) previous surgery for gastrointestinal cancer;(ii) enteral nutrition allergy, intolerance or contraindication; (iii) severe organ function abnormalities; (iv) history of miscommunication or psychiatric disorders; (v) illnesses inappropriate for participation.

### *Study grouping and interventions*

Based on the inclusion and exclusion criteria, 96 patients diagnosed with gastrointestinal cancer were eventually enrolled. These patients, who met the study criteria, were divided into two groups based on whether they received Oral Nutritional Supplements (ONS) at the first clinic visit: the control group (n=55) and the prehabilitation group (n=41) Figure 1 and 2). Clinical treatment included laparoscopic surgery for all patients following NCCN guidelines.

### *Nutritional support*

Routinely, dietitians evaluated the energy and food intake of enrolled patients. Following the guidelines of the European Society for Parenteral and Enteral Nutrition (ESPEN), a standard energy intake of 25-30 kcal/kg· d was recommended for patients. Dietitians conducted nutritional follow-up visits with patients on a weekly basis and provided recommendations for improvement accordingly.

### *Follow-up*

Data from patients in both groups were collected at their preoperative outpatient first visit and at discharge, respectively. The indicators included body weight, serum albumin level (ALB) and haemoglobin level (HB) (data from the hospital laboratory of Xuzhou medical and medical school), Nutrition Risk Screening-2002 (NRS2002) score, Hospital Anxiety and Depression Scale (HADS) score and MD Anderson Symptom Inventory (MDASI) score (data were collected and sorted by trained nutritionists). The incidence of related complications including intraoperative bleeding, operation time, postoperative infection, gastrointestinal fistula, ileus, and recovery days were compared between groups. Additionally, indicators of hospital stay, total expenditure, and unexpected readmission (patients with unplanned readmissions for the same or related illness within 31 days after discharge) were compared at discharge.

### *Statistical analysis*

Statistical analysis was conducted using SPSS 23.0 software. The normal test is carried out by Shapiro-Wilk method. For variables with a normal distribution were described using the mean and standard deviation (Mean ± SD), and the independent-samples t-test was applied for group comparisons. Non-normally distributed data were described using the median ($P_{25}$, $P_{75}$), and the Mann-Whitney U test was utilized for group comparisons. Categorical variables were presented as the number (n) and frequency (%), with group comparisons performed using $\chi^2$ test. Statistical significance was defined as $p < 0.05$ at the test level of $\alpha$=0.05.

## RESULTS

### *Baseline information of the study participants*

At baseline, no significant differences were observed between the two groups in terms of age, gender, NRS2002 scores, diabetes, hypertension, cancer site and clinical staging ($p < 0.05$) (Table 1). In addition, the levels of body weight, ALB and HB in the two groups were similar ($p < 0.05$) (Table 2).

There was no significant difference in HADS scores between the two groups ($p > 0.05$) (Table 3). Similarly, there was no significant difference in MDASI scores between the two groups at baseline ($p > 0.05$) (Table 4).

### *Nutritional status, mental health and symptom evaluation of the patients*

In terms of changes in ALB and HB levels, no significant difference was observed between the two groups ($p > 0.05$). However, regarding weight loss, the nutritional prehabilitation group showed significantly better out-

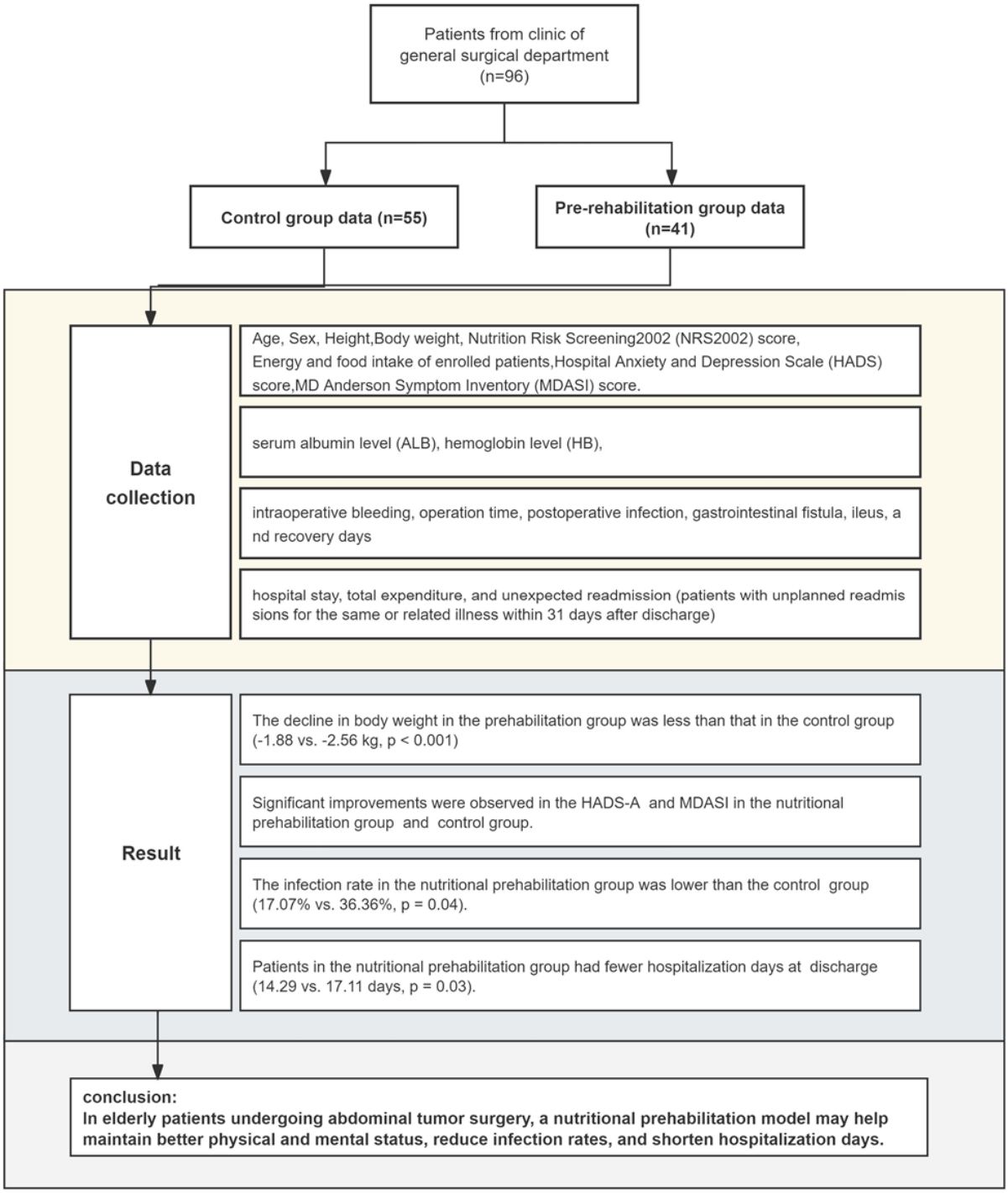


**Figure 1.** Graphical abstract

comes than the control group, with a statistically significant difference ($p < 0.001$) (Table 2).

There was no significant difference in the changes of HADS-D scores between the two groups ($p > 0.05$). However, the score in the nutritional prehabilitation group showed better improvement compared to the control group in terms of postoperative HADS-A ($p = 0.01$) (Table 3).

Additionally, there was no significant difference in the MDASI score between the two groups at baseline ($p > 0.05$). Nevertheless, the nutritional prehabilitation group demonstrated better improvement in MDASI compared to the control group ($p < 0.001$) (Table 4).

***Incidence of adverse events***

The infection rate was lower in the nutritional prehabilitation group compared to the control group ($p=0.04$) (Table 5).

Regarding intraoperative bleeding, there was no significant difference between the two groups ($p > 0.05$). Additionally, the duration of the operation in the nutritional prehabilitation group was also not significant different with that in the control group ($p > 0.05$) (Table 5).

***Hospitalization days and hospitalization costs***

There was no statistical difference in hospitalization costs and unexpected readmission between the two groups

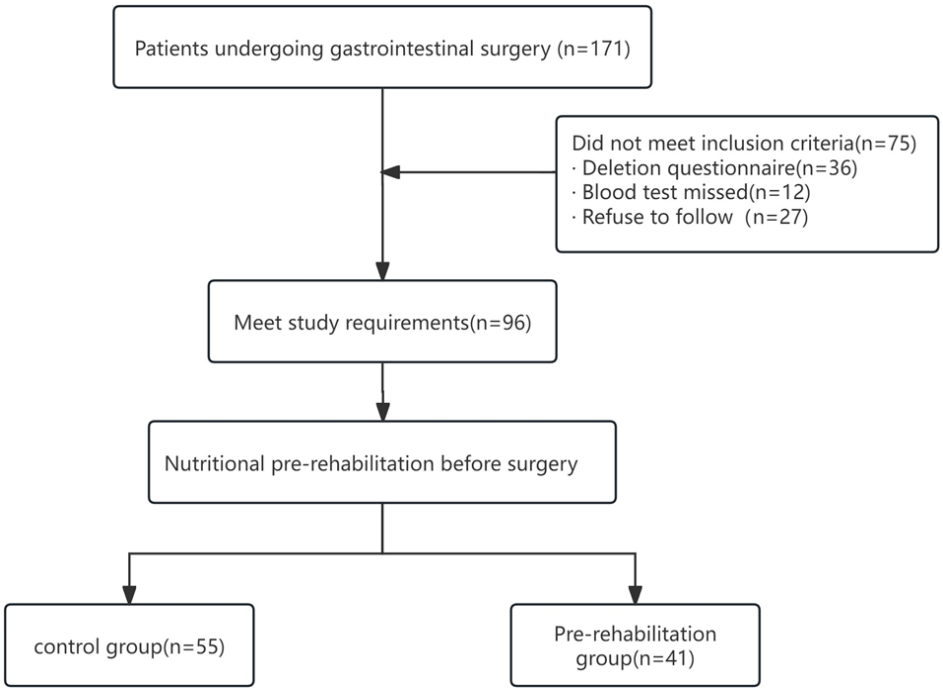


**Figure 2.** Screening and exclusion of subjects

**Table 1.** The study procedure

| | Control group (n=55) | Nutritional Prehabilitation group (n=41) | Statistics | *p* value |
|---|---|---|---|---|
| Age (years) † | 70.04±4.24 | 68.17±5.75 | *t*=-1.83 | 0.07 |
| Gender§ | | | | |
| Male | 40 (72.73%) | 22 (53.66%) | $\chi^2$=3.73 | 0.05 |
| Female | 15 (27.27%) | 19 (46.34%) | | |
| Diabetes§ | | | | |
| Yes | 10 (18.18%) | 7 (17.07%) | $\chi^2$=0.02 | 0.89 |
| No | 45 (81.82%) | 34 (82.93%) | | |
| Hypertension§ | | | | |
| Yes | 28 (50.91%) | 20 (48.78%) | $\chi^2$=0.04 | 0.84 |
| No | 27 (49.09%) | 21 (51.22%) | | |
| Cancer site§ | | | | |
| Gastrointestinal | 47 (85.45%) | 30 (73.17%) | $\chi^2$=2.23 | 0.14 |
| Other | 8 (14.55%) | 11 (26.83%) | | |
| Clinical Staging§ | | | | |
| Phase I+II | 22 (40.00%) | 19 (46.34%) | $\chi^2$=0.39 | 0.53 |
| Phase III+IV | 33 (60.00%) | 22 (53.66%) | | |
| NRS2002 (scores) ‡ | 4.00 (3.00-4.00) | 3.00 (3.00,4.00) | *Z*=-1.74 | 0.08 |

NRS2002, Nutrition risk screening-2002. NRS2002 score was non-normal distribution measurement data.
†Measurement data with normal distribution were represented by (Mean ± SD).
‡Non-normally distributed measurement data were represented by [M ($P_{25}$, $P_{75}$)].
§Categorical data are represented by [(n (%)].

throughout the treatment process ($p > 0.05$). However, the nutritional prehabilitation group had significantly fewer hospitalization days than the control group ($p$ =0.03) (Table 6).

## DISCUSSION

Recently, there has been a growing consensus that the success of surgery relies not only on surgical technique but also on patients' rapid recovery.[11] Surgical trauma triggers a stress response, leading to insulin resistance, immunosuppression, protein catabolism, and lean body mass loss. Preoperative malnutrition exacerbates these effects, increasing the risk of postoperative complications.[12] Even a single complication can lead to poorer outcomes.[13]

Elderly patients undergoing surgery face complex physiological changes, including reduced basal metabolic rate, enhanced proteolytic metabolism, suppressed lipolytic metabolism, and decreased glucose metabolic rate and tolerance. Additionally, elderly individuals are more prone to malnutrition due to cancer, which can decrease their surgical tolerance.[14, 15] Given these factors, elderly cancer patients are suitable candidates for prehabilitation, which enhances the body's functional reserves to withstand surgical trauma.[16]

Malnutrition is prevalent in patients undergoing gastrointestinal surgery, with up to 55% diagnosed upon admis-

**Table 2.** Changes in nutritional indicators between the two groups[†‡]

| Projects | Control group (n=55) | Nutritional prehabilitation group (n=41) | *t* value | *p* value |
|---|---|---|---|---|
| Body weight | | | | |
| Baseline | 63.3±9.88 | 64.9±11.6 | -0.41 | 0.69 |
| Ending | 60.7±9.78 | 62.3±11.7 | -0.71 | 0.48 |
| Difference | -2.56±0.75 | -1.88±0.91 | -3.99 | <0.001[§] |
| ALB | | | | |
| Baseline | 40.9±3.89 | 41.0±4.77 | -0.14 | 0.89 |
| Ending | 35.7±3.29 | 37.9±4.32 | -1.90 | 0.06 |
| Difference | -5.17±4.45 | -3.82±5.58 | -1.32 | 0.19 |
| HB | | | | |
| Baseline | 126±20.2 | 126±20.1 | 0.01 | 0.99 |
| Ending | 117±17.1 | 118±17.5 | -0.36 | 0.72 |
| Difference | -9.76±14.1 | -8.46±16.9 | -0.41 | 0.68 |

ALB, serum albumin; HB, haemoglobin
[†]The "baseline" means 1-3days before the surgery and the "ending" means 1 day before discharge, Difference = (baseline) – (ending).
[‡]All data were normal distribution data and were represented by (Mean ± SD).
[§]Comparison of Body weight (difference) between two groups

**Table 3.** Evaluation of the mental health status between the two groups[†‡]

| Projects | Control group (n=55) | Nutritional prehabilitation group (n=41) | *Z* value | *p* value |
|---|---|---|---|---|
| HADS-A | | | | |
| Baseline | 9 (8,10) | 9 (8,9) | -1.23 | 0.22 |
| Ending | 5 (5,6) | 5 (4,6) | -2.48 | 0.01[§] |
| Difference | -4 (-4, -3) | -4 (-5, -3) | -1.46 | 0.14 |
| HADS-D | | | | |
| Baseline | 9 (8,10) | 8 (7,10) | -1.20 | 0.23 |
| Ending | 5 (4,5) | 4 (4,6) | -0.95 | 0.34 |
| Difference | -4 (-5, -3) | -4 (-5, -3) | -0.42 | 0.68 |

HADS-A, Hospital Anxiety Scale; HADS-D, Hospital Depression Scale
[†]The "baseline" means 1-3days before the surgery and the "ending" means 1 day before discharge, Difference = (baseline) – (ending).
[‡]All data were non-normal distribution measurement data and were represented by [M (P25, P75)].
[§]Comparison of HADS-A(ending) between two groups

**Table 4.** MDSAI scores between the two groups[†‡]

| Projects | Control group (n=55) | Nutritional prehabilitation group (n=41) | *Z* value | *p* value |
|---|---|---|---|---|
| MDSAI (scores) (baseline) | 5 (4,6) | 6 (3,7) | -0.11 | 0.912 |
| MDSAI (scores) (ending) | 5 (3,7) | 2 (1,3) | -5.12 | <0.001[§] |
| Difference in score | 0 (0,1) | 3 (2,4) | -6.90 | <0.001[¶] |

MDASI, MD Anderson Symptom Inventory
[†]The "baseline" means 1-3 days before the surgery and the "ending" means 1 day before discharge, Difference in score = (baseline) – (ending).
[‡]MDSAI scores were non-normal distribution measurement data and were represented by [M ($P_{25}$, $P_{75}$)].
[§]Comparison of MDSAI (ending) between two groups
[¶]Comparison of MDSAI (difference) between two groups

sion.[17, 18] Malnutrition can impact postoperative complications and mortality,[17] but nutritional therapy can reduce complications and hasten recovery. Therefore, preoperative nutritional screening of elderly cancer patients is valuable.[11, 13, 19] For severely malnourished patients, postponing surgery may be considered to improve nutritional status.[18]

Many surgical patients suffer from malnutrition, weakness, and sarcopenia, with weakness observed in 84% and sarcopenia in 37% of patients.[18, 20] Nutritional therapy is cost-effective, but its implementation in clinical practice remains limited.[13, 21] Despite challenges, nutritional prehabilitation is recognized as crucial for high-quality postoperative care.[11]

Nutritional prehabilitation aims to provide nutritional reserves, improve metabolism, and enhance immunity for patients at nutritional risk.[13] It includes aggressive nutritional therapy, with protein intake recommendations ranging from (1.0-1.2g/kg) to (1.2-1.5g/kg) for elderly patients.[22, 23] Nutritional prehabilitation has been associated with reduced postoperative complications and shorter hospital stays.[11]

Our research focused on evaluating the positive outcomes of nutritional prehabilitation on elderly cancer patients following surgical intervention. Our findings indicate that the nutritional prehabilitation group displayed superior weight stability, a decreased risk of infection, improved psychological outcomes, and shorter hospital stays in comparison to the control group. In particular,

**Table 5.** Comparisons of treatment between the two groups

| Projects | Control group (n=55) | Nutritional prehabilitation group (n=41) | *Z* value | *p* value |
|---|---|---|---|---|
| Intraoperative blood loss (ml)† | 100 (50,200) | 100 (50,150) | *Z*=-1.49 | 0.14 |
| Time of operation (h)‡ | 3.53±1.21 | 3.02±1.21 | *t*=2.03 | 0.05 |
| Postoperative Complications§ | 32 (58.2%) | 17 (41.5%) | $\chi^2$=2.63 | 0.11 |
| Infection rate§ | 20 (36.4%) | 7 (17.1%) | $\chi^2$=4.32 | 0.04 |
| Gastrointestinal fistula§ | 10 (18.9%) | 4 (9.76%) | $\chi^2$=1.34 | 0.25 |
| Ileus§ | 4 (7.27%) | 1 (2.44%) | $\chi^2$=1.11 | 0.29 |
| Recovery days (days)¶ | 8 (7,10) | 7 (6,9) | *Z*=-1.28 | 0.20 |

†Intraoperative blood loss and Recovery days were non-normally distributed measurement data.
‡Measurement data with normal distribution were represented by (Mean ± SD).
§Non-normal distributed measurement data were represented by [M ($P_{25}$, $P_{75}$)].
¶Categorical data are represented by [(n (%)].

**Table 6.** Hospitalization between the two groups

| Projects | Control group (n=55) | Nutritional prehabilitation group (n=41) | Statistics | *p* value |
|---|---|---|---|---|
| Hospitalization days loss (ml)† | 17.1±7.05 | 14.3±4.84 | t=2.20 | 0.03 |
| Total expenses (CNY: ten thousand) ‡ | 6.63 (5.40,7.58) | 6.00 (4.88,6.86) | *Z*=-1.84 | 0.07 |
| Unexpected readmission§ ¶ | 4 (7.27%) | 3 (7.32%) | $\chi^2$=0.00 | 1.00 |

†Measurement data with normal distribution were represented by (Mean ± SD).
‡Non-normal distributed measurement data were represented by [M ($P_{25}$, $P_{75}$)].
§Categorical data were represented by [(n (%)].
¶Unexpected readmission, Patients with unplanned readmissions for the same or related illness within 31 days after discharge.

nutritional prehabilitation may be highly advantageous for malnourished or at-risk elderly cancer patients.

Existing studies have shown that the use of nutritional pre-healing in elderly cancer patients can help reduce the loss of weight after surgery.[24, 25] This conclusion is consistent with the results of this study, the nutritional pre-rehabilitation group which patients with the nutritional intervention before surgery was better at maintaining weight than the control group when the patient was discharged from the hospital. In addition, nutritional pre-rehabilitation is also beneficial for reducing postoperative complications.[17] The results showed that the risk of postoperative infection was significantly lower than in the control group (17.1% vs. 36.4%, $p$ = 0.04), which is suggested that the pre-rehabilitation strategy may help reduce the risk of postoperative infection in patients with abdominal cancer in the elderly. We're suggesting that the possible reason for this is that nutritional pre-rehabilitation effectively maintains the patient's immune levels. Unfortunately, this study failed to fully collect indicators such as the number of immune cells, such as lymphocytes, before and after the operation of two groups of patients.

It is well known that nutrition and mental health are closely related. The study showed that the anxiety and depression level of patients (according to HADS) decreased significantly after the preoperative recovery of patients with colorectal cancer. This study showed that patients with colorectal cancer had a significant lower anxiety and depression (according to HADS) after preoperative preparation. There are also relevant studies that can confirm this result, whereby a significant decrease in the level of anxiety and depression was observed after prehabilitation.[26]

The M.D. Anderson Symptom Inventory can be a simple and comprehensive assessment of the severity and treatment of cancer patients.[27] The study found that patients in nutritional pre-rehabilitation group were significantly better than the control group (5 vs.2, $p$<0.001). The current effect of pre-rehabilitation on residence and medical costs remains controversial.[28] This study supports the conclusion that pre-rehabilitation strategies can shorten hospitalization days. The results showed that the hospitalization days was shorter than the control group (14.3 vs. 17.1 days, $p$=0.03).

Based on these results, we speculate that improvements in these indicators may have been due to preoperative intervention. It may be due to the preoperative nutritional recovery that helps improve the nutritional state of patients with nutritional risk, ameliorate metabolic disorders and increase immune function.[13]

Oral Nutritional Supplements (ONS) are recommended for nutritional prehabilitation, providing convenient, cost-effective oral nutrition.[29] Triple prehabilitation, which includes exercise, nutrition, and psychology, is an ideal model for perioperative care in elderly patients,[9] especially those undergoing abdominal cancer surgery.

Although our study did not involve any rehabilitation physicians and cardiologists, further multicenter controlled studies are needed to validate our findings. As a retrospective study, it is inevitable that there are other factors not included in the study. Thus, it is necessary to conduct further prospective multicentred clinical controlled studies in the future.

### *Conclusion*

In conclusion, nutritional support plays a critical role in preoperative prehabilitation and significantly impacts the surgical treatment of elderly cancer patients. Our study

demonstrates that nutritional prehabilitation effectively maintains better nutritional status, reduces infection rates, alleviates anxiety, and shortens hospital stays in elderly patients undergoing abdominal surgery. Even for medical institutions unable to implement comprehensive triple prehabilitation, adopting a nutritional prehabilitation strategy can still contribute to improved prognoses for elderly patients with abdominal cancer to some extent.

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**CONFLICT OF INTEREST AND FUNDING DISCLOSURES**

The authors declare no conflict of interest.

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