

Analysis of Grip Strength and Its Explanatory Factors in Older Patients with Gastrointestinal Tumours

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Aim: To investigate the grip strength of older patients with gastrointestinal tumours and analyse its explanatory factors.

Methods: A total of 170 older patients with gastrointestinal tumours admitted to the Gastrointestinal Surgery Department of a Grade-III hospital in the Zhejiang province from January 2022 to December 2022 were selected as the investigation participants. Among them, there were 102 cases of gastric cancer (60.0%) and 68 cases of colon cancer (40.0%). There were 110 male patients (64.7%) and 60 female patients (35.3%), with patient ages ranging between 64 and 82 years old. A cross-sectional survey was conducted using a general data questionnaire, grip apparatus and the Nutritional Risk Screening 2002 (NRS-2002) score. Multiple linear regression was used to analyse the explanatory factors on the grip strength of older patients with gastrointestinal tumours.

Results: The grip strength of older patients with gastrointestinal tumours was 25.3 ± 5.3 kg. Multiple linear regression analysis showed that gender, age, disease, body mass index (BMI), albumin concentration and the NRS-2002 score were the main explanatory factors on grip strength ($P < 0.05$).

Conclusion: Grip strength was lower in older patients with gastrointestinal tumours and was lower in females, those aged ≥ 70 years, patients with colorectal cancer, individuals with a BMI of < 18.5 , those with an albumin concentration of < 35 g/l and those with an NRS2002 score of ≥ 3 . Clinical staff should dynamically evaluate the level of grip strength in patients with gastrointestinal tumors and develop individualized interventions based on the related explanatory factors.

Keywords: gastrointestinal tumour, grip strength, analysis of explanatory factors, nursing

Introduction

Due to various reasons, muscle mass and strength loss are common in patients with gastrointestinal tumours,¹ especially among those ≥ 60 years.² Decreased muscle strength will increase the risk of patients suffering from frailty, fall, disability and other adverse events.^{3,4} Professional muscle strength testing devices based on neuro-biomechanics⁵ are not popular in medical institutions due to their complicated, time-consuming and expensive operating process. Grip strength measurement using grip apparatus is a fast, simple, and low-cost muscle strength evaluation method suitable for clinical use.⁶ Grip strength reflects overall muscle strength and nutritional status, crucial for older gastrointestinal tumor patients. Low grip strength indicates higher risk of frailty and adverse outcomes. Monitoring it helps identify at-risk patients, allowing for timely interventions to improve nutritional status, muscle strength, and overall recovery. Many studies have shown that grip strength is closely related to the nutritional status and clinical prognosis of patients with tumours.⁷ Guerra et al⁸ found that the grip strength of malnourished patients with tumours was lower than that of patients with normal nutrition. The study of Li Huizi et al⁹ showed that the grip strength of patients with gastrointestinal tumours was significantly correlated with their albumin concentration, basal metabolic value and Nutritional

Risk Screening 2002 (NRS-2002) score. When the body is undernourished, muscle protein synthesis and muscle content decline, muscle fibre atrophy occurs and grip strength reduces.¹⁰ A prospective study in the UK¹¹ found a high negative correlation between grip strength and the incidence of malignant tumours and mortality. Reviewing the literature, the authors found that in current medical institutions, in addition to the data collection required for clinical research, the patients' grip strength measurements had not been fully carried out, and there are even fewer studies on the factors influencing grip strength in older patients with gastrointestinal tumours. This study aims to explore the relationship between grip strength in older gastrointestinal tumor patients and the severity of tumor progression, as well as to analyze the factors influencing grip strength. This study is important as it focuses specifically on older patients with gastrointestinal tumors, a demographic that has not been extensively studied in the context of grip strength. Additionally, it provides a comprehensive analysis of multiple explanatory factors, offering valuable insights for developing personalized interventions to improve patient outcomes, which distinguishes it from existing studies. The outcomes of this study can provide valuable insights for tailoring personalized nutritional plans and treatment strategies for gastrointestinal tumor patients at different stages.

Participants and Method

Survey Participants (Figure 1 Flowchart)

Eligible patients admitted to the Gastrointestinal Surgery Department of a Grade-III hospital in the Zhejiang province from January 2022 to December 2022 were selected as the study's participants using the convenience sampling method. According to the requirements of multiple linear regression analysis, the sample size was 5~10 times the number of independent variables, and a 15% sample shedding rate was considered. A total of 13 independent variables were included in this study, and the calculated sample size was 80~130 cases. At least 120 cases and 170 patients were eventually included in this study. The inclusion criteria were as follows: (1) Patients aged ≥ 60 years; (2) Patients with pathological findings showing gastrointestinal malignancies at stages I to III; (3) Patients with complete disease-related data including gender, age, marital status, education level, disease classification, tumor staging, BMI, albumin, NRS2002 score, sedentary time, history of smoking, history of hypertension, and history of diabetes; (4) Patients not receiving anti-tumour or surgical therapy prior to the investigation; (5) Patients who were conscious and able to communicate normally; (6) The patients and their families agreed to participate in the study and sign informed consent forms. The exclusion criteria were: (1) Patients whose conditions were complicated by other malignant tumours; (2) Patients unable to complete the grip strength and physical fitness tests for various reasons; (3) Patients who were participating in other research experiments. Please refer to the flowchart for details.

This study was approved by the hospital's Ethics Committee using the ethical approval form 2021-R125, and informed consent was given by all patients.

Survey Tools

By referring to a large amount of domestic and foreign literature relating to grip strength research^{12,13} and after consulting experts in gastrointestinal surgery, rehabilitation and nutrition, the relevant explanatory factors on grip strength were analysed, and a general data questionnaire was developed. This questionnaire was divided into two parts: (1) Demographic data comprising gender, age, marital status, educational background, body mass index (BMI), smoking history and daily sitting time; and (2) Disease-related data comprising grip strength, tumour type, tumour stage, albumin concentration, NRS-2002 score,¹⁴ history of diabetes and history of hypertension. The patient's sitting time was recorded according to their average daily sitting time (h/d) in the past year. Smoking ≥ 1 cigarette/day for a duration of ≥ 1 year was considered a history of smoking. The European Society for Clinical Nutrition and Metabolism (ESPEN) recommends using the NRS-2002 scale to assess patients' nutritional status, where a score of 0 to 2 indicates no nutritional risk, and a score of ≥ 3 indicates a nutritional risk. Additionally, tumor staging is classified into stages 1 to 3. Other disease staging information is obtained from medical records in the hospital.

Data Collection Methods

The method of field investigation was adopted. Two trained nurses explained the purpose and significance of this study to the patients who met the inclusion criteria within 24 hours of their admission, and the relevant data were collected on the spot after

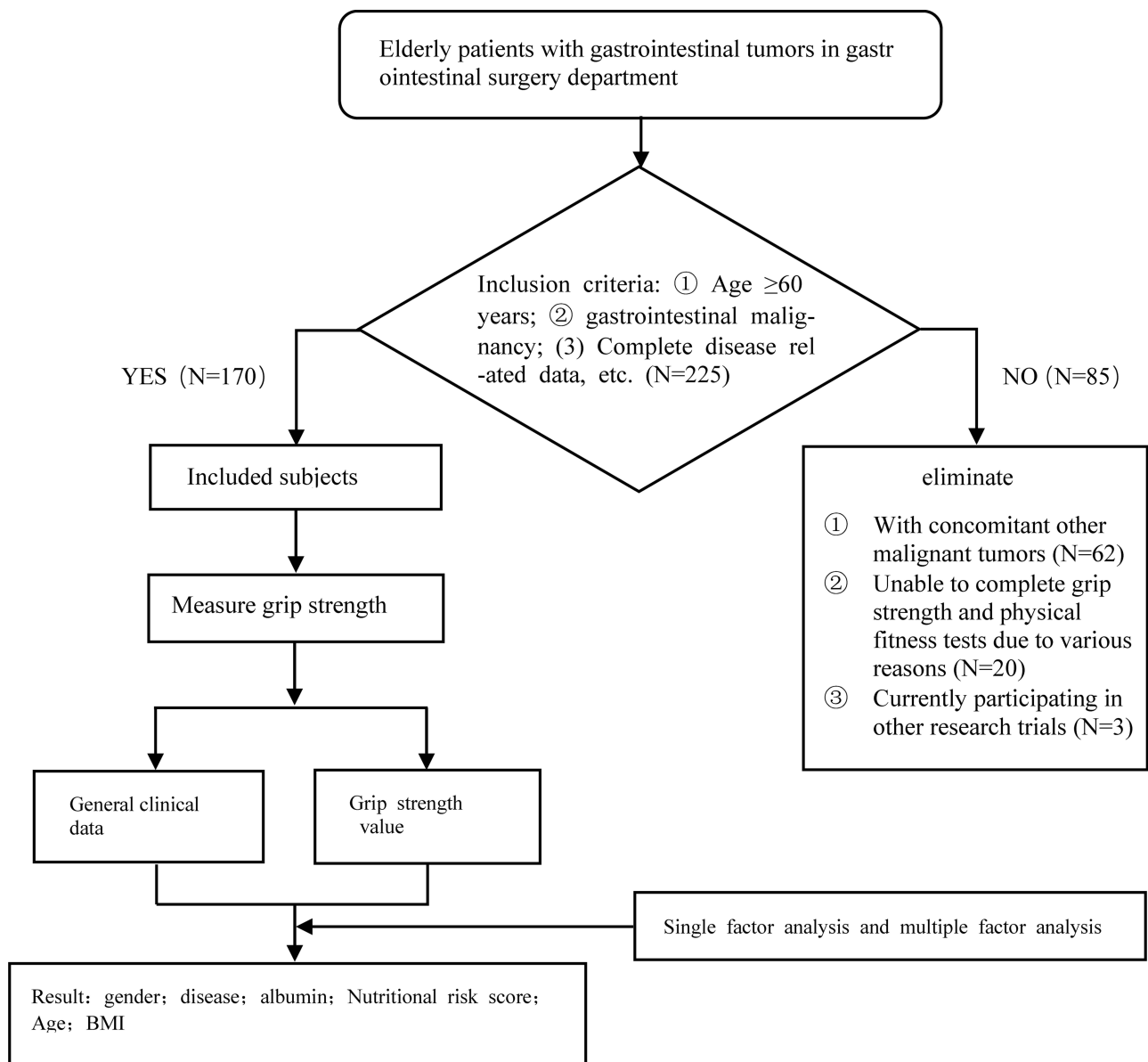


Figure 1 Flowchart.

obtaining consent. The steps were: (1) Before measuring grip strength, the patient rested for at least 1 min and was then asked to stand. The instructor used the spring-type grip strength device according to the measurement standard and measured the dominant and non-dominant hands of the participant three times, each with an interval of more than 30s. The measured grip strength was the average value of the maximum grip strength of the non-dominant and dominant hands.¹⁵ (2) Other clinical data were collected by two trained nurses within 24 hours following admission through the electronic medical record system.

Statistical Methods

We calculated the required sample size (N) by logistic regression using the formula, referring to the published reference.¹⁶

$$N = \frac{Z_{1-\alpha/2}^2 * p(1-p)}{d^2}$$

The event occurrence (p) is 0.8, Significance level (α) was set as 0.05, $Z_{1-\alpha/2}$ =Z-score corresponding to chosen significance level ($\alpha/2$). For $\alpha=0.05$, $Z_{1-\alpha/2}$ is approximately 1.96. Typically, effect sizes (d) was set 0.1 here. Based on

parameters above, we need approximately 62 samples for subsequent analysis, obtaining 102 cases of gastric cancer and 68 cases of colorectal cancer already satisfies the statistical requirements of this study. EpiData 3.1 software was used to input data, and SPSS Statistics 24.0 software was used for statistical analysis. The measurement data conforming to normal distribution were expressed by mean \pm standard deviation, and the count data were expressed by frequency and percentage. The independent samples *t*-test or one-way analysis of variance was used for comparison between groups. Multiple linear regression was used to analyse the explanatory factors, and a $P < 0.05$ was considered statistically significant.

Results

General Data and Grip Strength of Older Patients with Gastrointestinal Tumours

During this study, surveys were conducted on 255 older patients with gastrointestinal tumours, with a final inclusion of 170 patients in the study, excluding 85 patients. The reasons for exclusion included: 62 individuals with concomitant other malignant tumors, 20 patients unable to complete grip strength and physical fitness tests due to various reasons, and 3 patients currently participating in other research trials. There were 102 cases of gastric cancer (60.0%) and 68 cases of colorectal cancer (40.0%). There were 110 males (64.7%) and 60 females (35.3%). The patients' ages ranged from 64 to 82 (73.0 ± 4.3) years. The grip strength was 13.6–33.4 (25.3 ± 5.3) kg. Table 1 shows other general information.

Table 1 Univariate Analysis of Grip Strength in Elderly Patients with Gastrointestinal Cancer with Different Characteristics (n = 170)

Item	n (Percentage, %)	Grip Strength (kg)	t/F	p
1. Gender				
Male	110 (64.7)	28.2 \pm 3.7	15.102	0.000
Female	60 (35.3)	19.8 \pm 3.1		
2. Age				
<70	44 (25.9)	28.1 \pm 4.7	13.032	0.000
70–79	114 (67.1)	24.7 \pm 5.3		
\geq 80	12 (7.0)	20.6 \pm 2.2		
3. Marriage				
Married	157 (92.4)	25.4 \pm 5.4	-1.070	0.286
Other	13 (7.6)	23.7 \pm 4.7		
4. Education				
Primary school or below	120 (70.6)	25.4 \pm 5.5	0.798	0.452
Junior High School	35 (20.6)	24.3 \pm 4.9		
College or above	15 (8.8)	26.1 \pm 4.8		
5. Disease				
Gastric cancer	102 (60.0)	26.2 \pm 5.3	2.858	0.005
Colorectal cancer	68 (40.0)	23.9 \pm 5.1		
6. Tumor stage				
Phase I	26 (15.3)	29.9 \pm 3.7	24.287	0.000
Phase II	84 (49.4)	25.9 \pm 4.7		
Phase III	60 (35.3)	22.4 \pm 5.1		
7. BMI				
<18.5	14 (8.2)	20.8 \pm 4.8	15.728	0.000
18.5~	115 (67.7)	24.6 \pm 5.1		
\geq 24	41 (24.1)	28.6 \pm 4.4		
8. Albumin				
<35	48 (28.2)	22.8 \pm 5.0	-3.862	0.000
\geq 35	122 (71.8)	26.2 \pm 5.2		

(Continued)

Table 1 (Continued).

Item	n (Percentage, %)	Grip Strength (kg)	t/F	p
9. Nutritional risk				
No	82 (48.2)	27.7±4.3	6.491	0.000
Yes	88 (51.8)	23.0±5.2		
10. Sedentary time				
<2h	73 (42.9)	26.1±5.0	3.531	0.031
2–4h	75 (44.1)	25.3±5.5		
>4h	22 (12.9)	22.7±5.3		
11. Smoke				
No	116 (68.2)	25.6±5.3	1.042	0.299
Yes	54 (31.8)	24.6±5.4		
12. Hypertension				
No	103 (60.6)	25.2±5.5	-0.325	0.745
Yes	67 (39.4)	25.4±5.2		
13. Diabetes				
No	133 (78.2)	25.3±5.5	0.235	0.815
Yes	37 (21.8)	25.1±4.8		

Univariate Analysis of Grip Strength in Older Patients with Gastrointestinal Tumours

There were significant differences in grip strength among the older patients with gastrointestinal tumours and different genders, ages, diseases, tumour stages, BMI scores, albumin concentrations, NRS-2002 scores and sitting times ($P<0.05$). See [Table 1](#).

Multiple Linear Regression Analysis of Grip Strength in Older Patients with Gastrointestinal Tumours

The grip strength of the participants was taken as the dependent variable, and eight variables (gender, age, disease, tumour stage, BMI, albumin concentration, NRS-2002 score and sitting time) with statistical significance in the univariate analysis were taken as independent variables to conduct multiple linear regression analysis. [Table 2](#) shows the argument assignment method. The Results showed that gender, disease, albumin concentration, NRS-2002 score, age and BMI were the main factors affecting grip strength in older patients with gastrointestinal tumours ($P<0.05$). See [Table 3](#).

Table 2 Independent Variable Assignment Method

Independent Variable	Assignment Method
Gender	Female=0; Male=1
Age(year)	<70 ($Z_1=0, Z_2=0$); 70~<80 ($Z_1=1, Z_2=0$); ≥80 ($Z_1=0, Z_2=1$)
Disease	Gastric cancer=0; Colorectal cancer=1
Tumor stage	Phase I ($Z_1=0, Z_2=0$); Phase II ($Z_1=1, Z_2=0$); Phase III ($Z_1=0, Z_2=1$)
BMI	<18.5 ($Z_1=0, Z_2=0$); 18.5~<24.0 ($Z_1=1, Z_2=0$); ≥24.0 ($Z_1=0, Z_2=1$)
Albumin (g/l)	<30=0; ≥30=1
NRS 2002 score(score)	<3=0; ≥3=1
Sedentary time(h)	<2h ($Z_1=0, Z_2=0$); 2h~<4h ($Z_1=1, Z_2=0$); ≥4h ($Z_1=0, Z_2=1$)

Note: BMI is body mass index; NRS 2002 is Nutritional Risk Assessment Scale 2002.

Table 3 Multiple Linear Regression Analysis of Influencing Factors of Grip Strength in Elderly Patients with Gastrointestinal Cancer

Variable	Regression Coefficient	Standard Error	Standardized Regression Coefficient	T Value	P value
Constant	37.320	1.263		29.552	0.000
Gender	-7.773	0.443	-0.697	-17.531	0.000
Disease	-1.083	0.426	-0.100	-2.541	0.012
Albumin	1.350	0.474	0.114	2.848	0.005
Nutritional risk	-1.117	0.511	-0.105	-2.185	0.030
Tumor stage: Phase II	1.094	0.865	0.103	1.265	0.208
Tumor stage: Phase III	-0.403	0.964	-0.036	-0.418	0.676
Age: 70–79 years	-2.440	0.713	-0.215	-3.424	0.001
Age: ≥ 80 years	-5.422	1.091	-0.261	-4.970	0.000
BMI: 18.5–23.9	0.818	0.816	0.072	1.002	0.318
BMI: ≥24	1.963	0.938	0.158	2.094	0.038
Sedentary time 2–4h	0.264	0.445	0.025	0.592	0.554
Sedentary time > 4h	0.474	0.665	0.030	0.712	0.477

Discussion

The Current Status of Grip Strength in Older Patients with Gastrointestinal Tumours

Grip strength measurement can directly reflect overall muscle strength level and indirectly estimate muscle mass.¹⁷ This study shows that the grip strength of older patients with gastrointestinal tumours was 13.6–33.4 (25.3±5.3) kg (that of males 28.2±3.7 kg and that of females 19.8±3.1 kg), which was lower than that of patients with malignant tumours in the study of Lu Ting et al.¹⁸ This may be because all the participants in this study were older patients with gastrointestinal tumours. Affected by factors such as advanced age and digestive tract dysfunction, the decline in muscle mass and strength was more serious, and thus the grip strength of patients was worse. Medical staff should pay attention to the changes in grip strength of older patients with gastrointestinal tumours, identify the explanatory factors as early as possible and carry out effective interventions to improve patients' nutritional status and clinical prognosis.

The Influence of General Basic Data on Patients' Grip Strength

In this study, patients aged 60–69 years, 70–79 years and ≥80 years were divided into groups, and it was found that the grip strength of the patients in these different groups was statistically significant ($P<0.05$). Multiple linear regression analysis showed that the older the age, the lower the grip strength. Studies have shown that the annual rate of muscle mass loss in people over 80 is 3–5 times that in people 60 to 70 years.¹⁹ Due to degenerative changes in skeletal muscle structure and function owing to the ageing process, muscle mass and strength decline yearly,²⁰ resulting in decreased grip strength. This study shows that male grip strength is higher than female grip strength because the male body has a higher concentration of testosterone, which can promote protein synthesis²¹ so that muscle mass, strength and function are better in males than females. In this study, the grip strength of patients with colorectal cancer was lower than that of patients with gastric cancer. Grip strength can give feedback on body muscle mass and content, indicating that the nutritional level of patients with colorectal cancer was lower than that of patients with gastric cancer in this study, which is different from the results of previous studies.²² This is likely because the proportion of stage III tumours in patients with colorectal cancer in this study (47.1%, 32/68) was higher than that of patients with gastric cancer (27.5%, 28/102). This is consistent with the univariate analysis results showing a correlation between tumour stage and grip strength ($P<0.05$). It may be that the higher the tumour stage, the higher the systemic inflammation level, the higher the protein decomposition rate of the body, the more serious the muscle content reduction²³ and, thus, the lower the grip strength.

Therefore, medical staff should pay more attention to the grip strength level of older patients, female patients and patients with colorectal cancer, dynamically assess grip strength during hospitalisation and formulate corresponding exercise and nutritional intervention measures to delay or even improve patients' muscle strength and promote rapid recovery.

The Influence of Nutritional Indexes on Patients' Grip Strength

This study showed that patients with a higher BMI had a higher grip strength. Considering that (1) patients with a lower-than-normal BMI are more likely to suffer from malnutrition and more serious protein loss;²⁴ and (2) patients with a low BMI are more likely to develop osteoporosis and have low concentrations of vitamin D in the body, which can cause muscle fibre atrophy,²⁵ it is not surprising that a lower BMI can lead to decreased muscle mass and strength, manifesting as decreased grip strength. In this study, patients with an albumin concentration of ≥ 35 g/l had a higher grip strength than patients with an albumin concentration of < 35 g/l. The reasons for this are as follows: (1) Albumin concentration was proved to be able to estimate the relatively constant protein reserve status in the human body;²⁶ (2) Grip strength has, to some extent, been proven to be an indicator of human muscle strength.²⁷ (3) As 60% of the protein in the human body is stored in the muscles,²⁸ a decrease in albumin concentration can lead to insufficient muscle content, producing a decrease in grip strength. In this study, the grip strength of patients with an NRS-2002 score of ≥ 3 points was lower than that of patients with an NRS-2002 score of < 3 points; that is, those with nutritional risk had a lower grip strength. Research data show that as many as 70% of older patients with gastrointestinal tumours are at nutritional risk due to ageing, gastrointestinal dysfunction, the high metabolic status of the tumours and other factors.²⁹ The body is mainly manifested as energy-protein nutrient deficiency,³⁰ promoting the weakening of skeletal muscle function, which is reflected by declining grip strength. Domestic and foreign studies have pointed out^{1,12} that grip strength measurement can be used to assess the nutritional status of patients with high sensitivity, which is consistent with the conclusion of this study.

Therefore, medical staff should pay attention to the grip strength level of older gastrointestinal patients with a BMI < 18.5 , an albumin concentration of < 35 g/l and an NRS-2002 score of < 3 points. They should understand the muscle status of patients, pay attention to anti-tumour therapy, adopt multidimensional evaluation indicators to identify patients with malnutrition as early as possible and actively give individualised nutritional support to prevent or correct muscle loss in patients to improve clinical outcomes.

Limitations of This Study

The results of this study provide a reference value for the nutritional evaluation of grip strength in older patients with gastrointestinal tumours. However, this study has limitations: (1) The sample size is small, and the study site is single. In the future, it is advisable to expand the sample size and conduct multi-centre research to increase the value of the research results. (2) This study was a cross-sectional survey and did not dynamically monitor patients' grip strength changes. In the future, a longitudinal study on patients' grip strength should be further conducted to analyse the grip strength of older patients with gastrointestinal tumours at different periods. (3) Due to substantial individual differences among patients, we did not consider more additional factors such as patients' daily dietary habits and daily physical activities that might influence grip strength. (4) This study lacked detailed data on the previous nutritional status of the gastrointestinal cancer patients, which could influence grip strength.

Summary

Older patients with gastrointestinal tumours had a lower grip strength, and the main explanatory factors were gender, age, disease, BMI score, albumin concentration and NRS2002 score. And the grip strength of colorectal cancer patients is lower than that of gastric cancer patients. Clinical staff should develop individualized interventions based on the identified factors to improve grip strength and muscle function, promoting recovery and improving prognosis.

Data Sharing Statement

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of the First Affiliated Hospital of Ningbo University (2021-R125). Written informed consent was obtained from all participants.

Funding

This study was supported by Medical science and technology project of Zhejiang province: Based on the structural equation model in elderly patients with cancer of the stomach muscle disease status and influence factors of less analysis (2023KY1051) and Ningbo university first affiliated hospital scientific research projects: A risk factor for gastric cancer patients complicated with less muscle disease analysis and its correlation with clinical prognosis(H2022YJ010). Funding agencies did not play a role in study design, data collection, analysis and interpretation, and manuscript writing.

Disclosure

The authors report no conflicts of interest in this work.

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