Comparing the Adverse Outcomes of Different Frailty Subgroups by Employing the Tilburg Frailty Indicator (TFI) Among Elderly Patients with Gastric Cancer

Xueyi miao (1643570691@qq.com)
Nanjing Medical University

Lingyu Ding
Nanjing Medical University

Jinling Lu
Jiangsu Province People's Hospital and Nanjing Medical University First Affiliated Hospital: Jiangsu Province Hospital and Nanjing Medical University First Affiliated Hospital

Jieman Hu
Nanjing Medical University

Xinyi Xu
Queensland University of Technology - QUT: Queensland University of Technology

Hanfei Zhu
Nanjing Medical University

Li Chen
Jiangsu Province People's Hospital and Nanjing Medical University First Affiliated Hospital: Jiangsu Province Hospital and Nanjing Medical University First Affiliated Hospital

Qin Xu
Nanjing Medical University

Shuqin Zhu
Nanjing Medical University

Research Article

Keywords: Gastric cancer, frailty, elderly, Tilburg Frailty Indicator (TFI), adverse outcomes

Posted Date: February 1st, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1212962/v1

Abstract

Purpose: To classify the frailty subgroups by employing the Tilburg Frailty Indicator (TFI), as well as exploring the differences in postoperative total complications, length of stay (LOS), disability, and quality of life (QOL) between each subgroup among preoperative elderly gastric cancer patients.

Methods: Overall 290 patients were enrolled in this follow-up study. The TFI was used to collect the information of physical, psychological, and social frailty. The data of total complications and LOS were provided from the electronic medical records, while the data of disability and QOL were obtained from the telephone at 30 days after discharge.

Results: The TFI divided the preoperative elderly gastric cancer patients into eight frailty subgroups: exclusive physical frailty (18.3%), exclusive psychological frailty (20%), exclusive social frailty (3.4%), physical and psychological frailty (14.5%), physical and social frailty (3.4%), psychological and social frailty (3.4%), multidimensional frailty (4.8%) and full robust subgroup (32%). The multidimensional frailty subgroup had worse outcomes in total complications (P=0.001) and LOS (P□0.001) while the subgroup of physical and social frailty had poorer QOL (P=0.015) at 30 days after discharge.

Conclusion: The multidimensional frailty subgroup and the physical and social frailty subgroup should be of particularly concerned in the hospital and outside hospital according to our study. It also indicates that prehabilitation strategies can be developed precisely based on reported items to improve functional status of elderly gastric cancer patients. Further studies are needed to conduct in a longer-term period to capture significant change of other outcome indicators.

Introduction

Gastric cancer remains a major public health issue as the fourth leading cause of cancer-related deaths worldwide [1]. Surgery is the mainstay of treatment for gastric cancer. Owing to the aging population, the number of elderly patients undergoing gastric cancer surgery is gradually increasing. Their conditions have been seriously affected by the tumor, aging, multiple gastrointestinal symptoms, and abnormal nutrient metabolism, making the phenomenon of frailty prominent and common among them [2]. Frailty is defined as a state characterized by depletion of physiologic reserves arising from cumulative deficits in multiple homeostatic systems [3]. Elderly gastric cancer patients with frailty have a higher risk of adverse postoperative outcomes, such as complications, prolonged length of stay, poor quality of life, and disability [4–5]. Therefore, the preoperative management of frailty is particularly important among elderly patients with gastric cancer.

Numerous frailty instruments have been developed, which are commonly categorized into two types: unidimensionality and multidimensionality [6]. As research continues, it is believed that frailty involves multifaceted aspects and the multidimensional instruments may provide a more comprehensive picture of individuals' frailty status compared to the unidimensional one [7–8]. Tilburg Frailty Indicator (TFI) is one of the most promising multidimensional frailty instruments. It has been reported that the TFI showed the most robust reliability and validity among 38 multicomponent frailty instruments [9]. Derived from the integral conceptual model, the TFI is a user-friendly self-report questionnaire, which identifies frailty from three aspects: physical, psychological, and social domains with each domain have its own cutoffs [10]. A previous study illustrated that the TFI was feasible in a busy oncology setting and could be used for frailty evaluation among hospitalized older adults [11].

Elderly patients with gastric cancer are a highly heterogeneous group. Their physiological reserve, psychological state, and living environment are quite nonidentical before surgery, which probably cause frailty in different domains. Combining these different frailty domains, the different frailty subgroups are formed, which may be capable of recognizing the patient's status more accurately and predicting the adverse outcomes more targeted [12]. One study distinguished the community dwelling elderly individuals into four frailty subgroups and found that the subgroup of multidimensional frailty reported the most health deficits and required a comprehensive management strategy to improve not only their physical decline but also their psychological disturbances and social issues [13]. Another study concluded that older adults labeled as psychological and social frailty subgroup might show adverse outcomes of greater depression and lower social function compared with robust subgroup [14]. However, among elderly gastric cancer patients undergoing surgery, the status of frailty subgroups and the differences in adverse outcomes between each subgroup remains unclear, which hinders the effective identification of adverse outcomes and the individualized formulation of intervention strategies.

Therefore, our study aimed to use the TFI to classify the frailty subgroups among elderly gastric cancer patients before surgery, as well as exploring the differences in adverse outcomes between each subgroup.

Material And Methods

Study Population and Data Collection

This was a follow-up study. We conducted convenience sampling among the patients with gastric cancer at a tertiary hospital in China, from March 2021 to September 2021.

The inclusion criteria included patients who: (1) diagnosed with gastric cancer by endoscopy or pathology; (2) planned to receive radical surgery for the first time; (3) aged ≥60 years.The exclusion criteria included patients who: (1) with severe physical disability or cognitive impairment (determined by a score ≥ 8 on the Short Portable Mental Status Questionnaire [15]); (2) received preoperative radiotherapy or chemotherapy; (3) with other sites of malignant tumors; (4) with severe heart, liver, or renal insufficiency.

The enrolled patients would be collected baseline information and measured for frailty by researchers within 24 hours after admission. The postoperative total complications and length of stay (LOS) were captured from the electronic medical records while the information of disability and quality of life (QOL) was obtained by researchers from the telephone at 30 days after discharge.

Ethical Considerations

All patients signed informed consent after being informed that their clinical information would be used anonymously for research. The study was approved by the Ethics Committee of our university in China (Number: 2020-273). The study was verified by the Chinese Clinical Trial Registry (Number: ChiCTR2100052769).

Measurements

Baseline Information

Baseline data were collected on demographic characteristics (age, gender, BMI, marital status), and disease-related information (cancer stage, and type of surgery).

Frailty Instrument

Frailty was investigated with part B of the TFI which include 15 frailty deficits mapping into three domains: physical, psychological, and social frailty [10]. The 8 components of physical frailty are poor physical health, unexplained weight loss, difficulty in walking, difficulty in maintaining balance, poor hearing, poor vision, lack of strength in the hands, and physical tiredness. The 4 items of psychological domain are problems with memory, feeling down, feeling nervous or anxious and unable to cope with problems. The social frailty consists of living alone, lack of social relations (loneliness) and lack of social support. The sore of the TFI range from 0-15, and the defined cutoff points are 5, 3, 2, and 2 for total, physical, psychological, and social frailty, respectively [16]. The TFI has been extensively culturally adapted and validated in China [17].

Outcome Measures

We assessed postoperative complications and LOS as in-hospital outcomes. Postoperative complications were graded by Clavien-Dindo classification and total complications were considered as Clavien-Dindo grade ≥ 2 according to previous studies [18]. LOS was defined from the data of admission to date of discharge.

The out-of-hospital outcomes included disability and QOL at 30 days of discharge. Disability was assessed by Elderly Disability Assessment Scale (EDAS) [19], which developed based on the ICF theoretical framework and the survey data of the Chinese elderly population. The EDAS comprises 28 items focusing on 7 domains: mental function, organ function, communication, activity, self-care ability, family life, economic and social life. The scores of EDAS range from 28-196, with lower scores representing more severe disability. The EDAS has been validated in China and Cronbach's α for total scale was 0.966 [20]. QOL was measured using the validated Chinese version of the gastric cancer-specific module of the European Organization for Research and Treatment of Cancer (EORTC QLQ-STO22) [21]. The Cronbach's α coefficient was above 0.7 for the total scale. The EORTC QLQ-STO22 including 22 questions evaluating 9 symptom scales: dysphagia, eating restriction, pain, reflux, anxiety, dry mouth, body image, hair loss and taste problem. Each scale is represented by a score ranging from 0 to 100 with higher score indicating poorer QOL.

Statistical Analysis

Descriptive data that in normal distribution were presented as mean ± standard deviation (SD) for continuous variables, otherwise, they were presented as the median to enable numerical comparisons. Frequencies and percentages were used as appropriate for categorical variables. The sample size was estimated based on the PASS version 15.0 (PASS 15 Power Analysis and Sample Size Software, NCSS, LLC). One previous study showed that the prevalence of frailty in preoperative patients with gastric cancer was 17.71% [22]. Considering the missing rate of 10%, the minimum sample in our study was 267 patients. We used the non-parametric Kruskal–Wallis test to analyze differences between LOS, QQL, and disability since the data didn't follow a normal distribution. The Bonferroni multiple comparison test was employed for post hoc analyses and adjusted for *P*-value [23]. As for the categorical variables, the chi-square test was performed with $P < 0.05$ considering statistically significant. While employed post hoc analyses, the partitions of c^2 method was used to estimate the differences between two of the groups, with level of significance changed into $\alpha < 0.002$ (to reduce class I errors) [24]. Statistical analysis was performed using SPSS (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp).

Results

Participants Characteristics

Initially, 321 elderly patients undergoing gastrectomy met our inclusion criteria. 26 patients were excluded because they have severe physical disability or refused to participate in the study. 2 patients were excluded due to death during the follow-up, and 3 patients were excluded due to the loss of follow-up. Finally, a total of 290 patients were enrolled in this study (90.3% response rate). The mean age of study participants was 68.7±5.4 years, 223 (76.9%) were male and 266 (91.7%) were married or cohabiting. In regard to the TFI, the prevalence of total, physical, psychological, and social frailty was 52.1%, 41%, 43.1%, and 13.8%, respectively. For the adverse outcomes, the incidence of total complications was 17.2% while the median of LOS, disability and QOL were 15.5 days, 183 and 17.1, respectively. The detailed characteristics of the participants are presented in Table 1.

Table 1
Characteristics of Participants (N = 290)

Variables	n (%)/Mean±SD	Variables	n (%)/Median
Age (years)	68.7±5.4	Difficulty in maintaining balance	1(0.3)
BMI (kg/m^2)	23.4±2.9	Poor hearing	60(20.7)
Gender		Poor vision	101(34.9)
Male	223(76.9)	Lack of strength in the hands	127(43.8)
Female	67(23.1)	Physical tiredness	164(56.6)
Marital status		Psychological frailty(≥2)	125(43.1)
Married or cohabiting	266(91.7)	Psychological frailty components	
Divorced or widowed	24(8.3)	Problems with memory	49(16.9)
Surgical approach		Feeling down	166(57.2)
Open	59(20.3)	Feeling nervous or anxious	127(43.8)
Laparoscopic	231(79.7)	Unable to cope with problems	14(4.8)
Cancer stage *		Social frailty(≥2)	40(13.8)
I	111(38.3)	Social frailty components	
II	109(37.6)	Living alone	15(5.2)
III and above	70(24.1)	Lack of social relations	275(94.8)
Frailty characteristics		Lack of social support	37(12.6)
Total frailty(≥5)	151(52.1)	Total complications	
Physical frailty(≥3)	119(41)	Grade≥2	50(17.2)
Physical frailty components		Grade<2	240(82.8)
Poor physical health	71(24.5)	Length of stay(days)	15.5
Unexplained weight loss	114(39.3)	Disability	183
Difficulty in walking	18(6.2)	QOL	17.1

Note. BMI, Body Mass Index; QOL, Quality of Life; SD, Standard Deviation; * Cancer Stage was graded by Tumor Node Metastasis (TNM).

Frailty Subgroups

The three domains of the TFI divided the preoperative elderly gastric cancer patients into eight frailty subgroups: exclusive physical frailty (18.3%), exclusive psychological frailty (20%), exclusive social frailty (3.4%), physical and psychological frailty (14.5%), physical and social frailty (3.4%), psychological and social frailty (3.4%), multidimensional frailty (physical, psychological, and social frailty) (4.8%) and full robust subgroup (32%). Furthermore, the specific frailty items reported in different subgroups varied widely. The detailed results of frailty subgroups and items of the TFI are shown in Table 2.

Table 2
Comparison of TFI Items between Different Frailty Subgroups

Variables n (%)/Mean±SD	Exclusive physical frailty	Exclusive psychological frailty	Exclusive social frailty	Physical & psychological frailty	Physical & social frailty	Psychological & social frailty	Multidimensional frailty	Full robust	*P* value
N	53(18.3)	58(20)	10(3.4)	42(14.5)	10(3.4)	10(3.4)	14(4.8)	93 (32)	<0.001
Age (years)	70.6±5.2	66.3±4.3	69.3±5	70.6±5.8	69.1±6.5	67.1±3.7	68.7±4.9	68.5±5.6	
BMI (kg/m^2)	23.2±3.1	23.9±2.8	21.9±2.6	22.8±3.2	22±2.4	24±2	24.6±3.2	23.7±2.8	*0.068*
Gender									
Male	46(86.8)	40(69)	7(70)	28(66.7)	8(80)	6(60)	11(78.6)	77(82.8)	*0.1*
Female	7(13.2)	18(31)	3(30)	14(33.3)	2(20)	4(40)	3(21.4)	16(17.2)	
Marital status									
Married or cohabiting	50(94.3)	57(98.3)	6(60)	41(97.6)	7(70)	7(70)	9(64.3)	89(95.7)	<0.001
Divorced or widowed	3(5.7)	1(1.7)	4(40)	1(2.4)	3(30)	3(30)	5(35.7)	4(4.3)	
Surgical approach									
Open	41(77.4)	49(84.5)	10(100)	26(61.9)	8(80)	9(90)	10(71.4)	78(83.9)	*0.066*
Laparoscopic	12(22.6)	9(15.5)	0	16(38.1)	2(20)	1(10)	4(38.6)	15(16.1)	
Cancer stage *									
I	19(35.8)	24(41.4)	6(60)	8(19)	2(20)	5(50)	3(21.4)	44(47.3)	*0.064*
II	17(32.1)	19(32.8)	3(30)	22(52.4)	5(50)	3(30)	5(35.7)	35(37.6)	
III and above	17(32.1)	15(25.9)	1(10)	12(28.6)	3(30)	2(20)	6(42.9)	14(15.1)	
Physical frailty components									
Poor physical health	23(43.4)	5(8.6)	0	21(50)	6(60)	2(20)	5(35.7)	9(9.7)	<0.001
Unexplained weight loss	29(54.7)	15(25.9)	4(40)	29(69)	7(70)	0	4(28.6)	26(28)	<0.001
Difficulty in walking	6(11.3)	0	0	8(19)	1(10)	0	3(21.4)	0	<0.001
Difficulty in maintaining balance	0	0	0	1(2.4)	0	0	0	0	*0.296*
Poor hearing	22(41.5)	7(12.1)	3(30)	12(28.6)	2(20)	3(30)	2(14.3)	9(9.7)	<0.001
Poor vision	30(56.6)	16(27.6)	1(10)	14(33.3)	6(60)	4(40)	11(78.6)	19(20.4)	<0.001
Lack of strength in the hands	39(73.6)	13(22.4)	2(20)	29(69)	7(70)	4(40)	11(78.6)	22(23.7)	<0.001
Physical tiredness	46(86.8)	26(44.8)	2(20)	37(88.1)	8(80)	3(30)	13(92.9)	29(31.2)	<0.001
Psychological frailty components									
Problems with memory	10(18.9)	11(19)	1(10)	9(21.4)	0	3(30)	4(28.6)	11(11.8)	*0.335*
Feeling down	17(32.1)	56(96.6)	3(30)	42(100)	4(40)	10(100)	11(78.6)	23(24.7)	<0.001
Feeling nervous or anxious	2(3.8)	55(94.8)	2(20)	38(90.5)	1(10)	10(100)	13(92.9)	6(6.5)	0.000
Unable to cope with problems	0	1(1.7)	0	5(11.9)	0	1(10)	6(42.9)	1(1.1)	<0.001
Social frailty components									
Living alone	0	0	4(40)	0	2(20)	3(30)	6(42.9)	0	<0.001

Note. Significant *P* values in bold; BMI, Body Mass Index; SD, Standard Deviation; * Cancer Stage was graded by Tumor Node Metastasis (TNM).

Variables n (%)/Mean±SD	Exclusive physical frailty	Exclusive psychological frailty	Exclusive social frailty	Physical & psychological frailty	Physical & social frailty	Psychological & social frailty	Multidimensional frailty	Full robust	*P* value
Lack of social relations	51(96.2)	54(93.1)	10(100)	39(92.9)	10(100)	10(100)	14(100)	87(93.5)	*0.985*
Lack of social support	0	0	8(80)	1(2.4)	10(100)	9(90)	7(50)	2(2.2)	<0.001

Note. Significant *P* values in bold; BMI, Body Mass Index; SD, Standard Deviation; ***** Cancer Stage was graded by Tumor Node Metastasis (TNM).

Differences In Adverse Outcomes Between Frailty Subgroups

There were significant differences in LOS (*P*<0.001), total complications rate (*P*=0.001) and QOL (*P*=0.015) between frailty subgroups. Compared with the subgroups of exclusive psychological frailty (*P*<0.001), exclusive social frailty (*P*=0.022), psychological and social frailty (*P*=0.027) and full robust (*P*=0.001), the multidimensional frailty subgroup had longer LOS. Meanwhile, the total complications rate of the multidimensional frailty subgroup was much higher than that of the full robust subgroup (χ^2 = 11.2, *P*=0.001). In terms of the out-of-hospital outcomes, the subgroup of physical and social frailty had poorer QOL than exclusive psychological frailty (*P*=0.04) and full robust subgroup (*P*=0.007), while disability had no statistical significance between each subgroup (*P*=0.063). For more details, refer to Table 3.

Table 3
Comparison of Adverse Outcomes between Different Frailty Subgroups

Variables n (%)/Median	Exclusive physical frailty	Exclusive psychological frailty	Exclusive social frailty	Physical & psychological frailty	Physical & social frailty	Psychological & social frailty	Multidimensional frailty	Full robust	*P* value
Total complications	14(26.4)	8(13.8)	0	11(26.2)	0	0	7(50) [a]	10(10.8) [a]	0.001
LOS (days)	16(14-19)	14(12-17.8) [b]	13.5(12.3-17.8) [c]	16(14-19.8)	18(14.3-20.8)	14(12.3-16.5) [d]	22(18-29.8) [b,c,d,e]	15(13-18) [e]	<0.001
Disability	182(175-187)	184(177-188)	186(181.3-189.5)	180(173.3-185.8)	186.5(176.8-188.8)	183(181-191)	178.5(172.5-183.5)	184(178-189)	*0.063*
QOL	17.3(14.5-21.6)	15(10.5-27.4) [f]	21.1(19.2-23.1)	18.4(11.7-25.3)	29.8(23.9-34.6) [f,g]	15.9(9.3-22.7)	17.6(15.6-21)	15.7(9.6-23.1) [g]	0.015

Note. Significant P values in bold. a Denoted that full robust vs multidimensional frailty was statistically significant (χ2=11.2, P=0.001) and level of significance changed into α < 0.002; b,c,d,e denoted that the P values of exclusive psychological frailty, exclusive social frailty, psychological & social frailty, and full robust vs multidimensional frailty were P<0.001, P=0.022, P=0.027, and P=0.001, respectively; f,g denoted that the P values of exclusive psychological frailty and full robust vs physical & social frailty were P=0.04 and P=0.007, respectively.

Discussion

Many studies have shown that frailty was a strong predictor of adverse outcomes among elderly patients with gastric cancer [4,22]. Frailty includes multiple aspects and subgroup classification of frailty allows for more accurate preoperative risk stratification and adverse outcomes prediction among these patients. In our study, the prevalence of three frailty domains measured by the TFI ranged from 13.8–43.1%. By using the cutoffs of each dimension, we divided the preoperative elderly gastric cancer patients into eight frailty subgroups. The multidimensional frailty subgroup had much worse outcomes in the hospital while the subgroup of physical and social frailty had poorer QOL at 30 days after discharge. Besides, there was no statistical significance between frailty subgroups regarding to disability.

Our results demonstrated that the preoperative elderly patients with gastric cancer from the multidimensional frailty subgroup had much worse outcomes when it comes to the in-hospital outcomes. Possibly because that patients from the multidimensional frailty subgroup have problems in multiple aspects. Studies have revealed that about half of the hospitalized older adults had 2 or perhaps 3 of physical debilitating conditions while the most of these patients also suffer from psychological and social issues, such as anxiety, depression, and low social support [25–26]. Furthermore, studies have shown that there were some interactions between these three domains of the TFI [12], contributing to the acceleration of frailty development. It implies that these three domains cannot be seen in isolation from each other when assessing frailty.

Previous studies are in accordance with our results. Nigel et al found that the addition of psychological frailty and social frailty to physical frailty was able to identify older adults with much higher risk of nursing home referral and disability [27]. Another study showed that combining various frailty domains increased the mortality hazard ratio (HR) of community-dwelling older adults, the HR with one frailty domain was 1.9, and with three frailty domains was 10.4 [28]. However, compared with community-dwelling older adults, elderly patients with gastric cancer are affected by both aging and tumor, which leads to a more complicated frailty status. Future studies should explore more specific frailty domains, such as the domain of gastrointestinal symptoms, so that the comprehensively frailty status can be evaluated in the oncology setting. From the practical point of view, it indicates that frailty status of preoperative elderly gastric cancer patients should be recognized by using validated multidimensional frailty instruments such as the TFI, and then, health professionals can

provide individualized prehabilitation intervention to these patients according to its reported specific frailty domains or even items that uncovering individual's needs and lacks, making the interventions more feasible and effective.

Our findings revealed that the elderly gastric cancer patients from the multidimensional frailty subgroup reported the most deficits, which is consistent with previous study among community-dwelling elderly adults [13]. In the multidimensional frailty subgroup, difficulty in walking, poor vision, lack of strength in hands, physical tiredness were the most prevalent physical deficits while feeling nervous or anxious, unable to cope with problems and living alone were in dominance of psychological and social frailty. According to the reported items above, some targeted intervention strategies can be tailored. Physical exercise improves walking and muscle endurance as well as increasing muscle strength while nutrition interventions may aim at preserving muscle mass, counteracting physical performance decline, and promoting robustness [29–30]. Moreover, the information support and mental care can relieve anxiety and improve the psychological mindset greatly [31]. By combining these intervention components, a prehabilitation strategy can be formed precisely. Studies have discovered that multimodal prehabilitation before surgery which involved exercise training, nutrition, and mental support can significantly reduce postoperative complications and LOS of patients with gastrointestinal tumors [32–33]. Vision problem is critical because it may increase the risks of frailty development, which probably lead to a certain degree of poor prognosis [34]. Such sensory impairment can be solved with appropriate glasses and health professionals should be alert of patients from this subgroup to fall or get injured due to lack of eyesight. Living alone can augment mortality risk in individuals with limited social ties and being loneliness [35]. Hence, hospitals or communities should establish gastric cancer groups with the aim of encouraging these patients to communicate with each other and increase the sense of social engagement.

During the period after discharge, QOL becomes one of the major outcomes to be concerned about [36]. We observed that the subgroup of physical and social frailty had worse QOL at 30 days after discharge compared with the subgroup of exclusive psychological frailty and full robust. This can be related to the series of vicious cycles between physical frailty and social frailty. Postoperative elderly patients with gastric cancer often suffer from postoperative fatigue (POF) and some specific postoperative physical issues such as intolerance of oral intake, intra-abdominal abscess, and delayed gastric emptying, resulting in severe reduction of social activities [37–38]. In parallel, the limited social activities probably contribute to a decline in skeletal muscle metabolism, which in turn leads to muscle atrophy, reduced physical performance, and impaired independence [39]. Besides, patients from this subgroup reported poor physical health and lack of social support as the most common problems before surgery. These problems may still exist during the critical phases of postoperative recovery, which possibly causes a sharp decline in their QOL. It implies that we should focus on both physical and social frailty components continuously even in the postoperative phase as a way to effectively improve the QOL of elderly patients with gastric cancer.

Finally, we observed that there was no significant difference in disability between each subgroup. Evidence had been proven that frailty may be a physiological precursor and etiologic factor in disability [40]. Considering that disability is a more extreme negative status, it may require long-term accumulation of health defects. A previous study on TFI predicting adverse outcomes lasted for two years and showed that TFI was available to predict disability among the elderly [41]. However, our study only lasts for a short time, it suggests that longer follow-up may be needed in the future. Moreover, the overall function of most elderly gastric cancer patients was generally poor due to the surgery or postoperative symptoms at 30 days of discharge, this can also explain the non-statistically significant of disability among the subgroups at this period.

Some limitations of this study should be noted. First, the sample size was obviously insufficient because some subgroups only contained ten patients. Future research may consider expanding the sample size to conduct more empirical research. Additionally, the confounding factors of age and marital status were unadjusted in our study, other statistical methods such as regression analysis can be used in the future to adjust for confounding factors. Moreover, the follow-up period in our study was probably too short to capture great changes in disability. Longer follow-up and larger prospective cohort studies may be considered in the future.

Conclusion

The multidimensional instruments may help to assess the patient's frailty more comprehensively in the clinical setting. Our study showed that the TFI is feasible to recognize the frailty subgroups among elderly gastric cancer patients before surgery. By combining frailty domains of the TFI, eight different frailty subgroups can be distinguished. The multidimensional frailty subgroup and the physical and social frailty subgroup should be of particularly concerned in the hospital and outside hospital, respectively. Besides, it also indicates that prehabilitation strategies can be tailored precisely based on the reported items to improve overall functional status of preoperative elderly gastric cancer. Further studies are needed to conduct in a longer-term period to capture significant change of other outcome indicators.

Declarations

Fundings: Project "The exploration of trajectories and intervention program of frailty for gastric cancer survivors based on the health ecology theory" supported by NSFC (No.82073407); Project "Studies on Construction of Core Competency Model and Development of Assessment Tool for Nurses of Hospice Care" supported by NSFC (No.72004099); Project of "Nursing Science" Funded by the Priority Discipline Development Program of Jiangsu Higher Education Institutions (General Office, the People's Government of Jiangsu Province, 2018, No.87).

Acknowledgments: We thank the support of the National Natural Science Foundation of China (NSFC) and Jiangsu Higher Education Institutions for this study.

Disclosure: The authors report no conflicts of interest in this work.

Availability of data and material: The data used during our study are available from the corresponding author on reasonable request.

Code availability: Not applicable.

Authors' contributions: Xueyi Miao, Lingyu Ding, Jinling Lu, Li Chen, Jieman Hu are responsible for acquisition and interpretation of data; Xueyi Miao, Lingyu Ding are responsible for drafting of the manuscript; Xinyi Xu, Hanfei Zhu, Qin Xu, and Shuqin Zhu are responsible for critical revision of the manuscript for important intellectual content.

Ethics approval: The study was approved by the Ethics Committee of Nanjing Medical university, Jiangsu, China, (Number: 2020-273). The study was verified by the Chinese Clinical Trial Registry (Number: ChiCTR2100052769).

Consent to participate: All the patients enrolled in our study signed the informed consent.

Consent for publication: Informed consent for publication of their clinical details was obtained from the patient in our study.

References

1. Sung H, Ferlay J, Siegel RL et al (2021) Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin 71:209–249
2. Tanaka T, Suda K, Inaba K et al (2019) Impact of Frailty on Postoperative Outcomes for Laparoscopic Gastrectomy in Patients Older than 80 Years. Ann Surg Oncol 26:4016–4026
3. Proietti M, Cesari M, Frailty (2020) What Is It? Adv Exp Med Biol 1216:1–7
4. Ding L, Lu J, Zhu H et al (2021) Effects of preoperative frailty on outcomes following surgery among patients with digestive system tumors: A systematic review and meta-analysis. Eur J Surg Oncol 23:S0748–7983
5. Shen Y, Hao Q, Zhou J et al (2017) The impact of frailty and sarcopenia on postoperative outcomes in older patients undergoing gastrectomy surgery: a systematic review and meta-analysis. BMC Geriatr 17:188
6. Van der Elst MCJ, Schoenmakers B, Op Het Veld LPM et al (2019) Concordances and differences between a unidimensional and multidimensional assessment of frailty: a cross-sectional study. BMC Geriatr 19:346
7. Satake S, Arai H (2020) Chapter 1 Frailty: Definition, diagnosis, epidemiology. Geriatr Gerontol Int Suppl 1:7–13
8. Gobbens RJJ, Andreasen J (2020) The prediction of readmission and mortality by the domains and components of the Tilburg Frailty Indicator (TFI): A prospective cohort study among acutely admitted older patients. Arch Gerontol Geriatr 89:104077
9. Sutton JL, Gould RL, Daley S et al (2016) Psychometric properties of multicomponent tools designed to assess frailty in older adults: A systematic review. BMC Geriatr 16:55
10. Gobbens RJ, Schols JM, van Assen MA (2017) Exploring the efficiency of the Tilburg Frailty Indicator: a review. Clin Interv Aging 12:1739–1752
11. Chong E, Ho E, Baldevarona-Llego J et al (Frailty and Risk of Adverse Outcomes in Hospitalized Older Adults: A Comparison of Different Frailty Measures. J Am Med Dir Assoc 2017) ;18:638.e7-638.e11
12. Sacha M, Sacha J, Wieczorowska-Tobis K (2020) Determinants of Multidimensional and Physical Frailty and Their Individual Components: Interactions between Frailty Deficits. Int J Environ Res Public Health 17:8656
13. Sacha M, Sacha J, Wieczorowska-Tobis K (2020) Simultaneous Employment of the FRAIL Scale and the Tilburg Frailty Indicator May Identify Elderly People Who Require Different Interventional Strategies. Clin Interv Aging 15:683–690
14. Roppolo M, Mulasso A, Gobbens RJ et al (2015) A comparison between uni- and multidimensional frailty measures: prevalence, functional status, and relationships with disability. Clin Interv Aging 10:1669–1678
15. Pfeiffer E (1975) A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc 23:433–441
16. Gobbens RJJ, van Assen MALM, Augustijn H et al (Prediction of Mortality by the Tilburg Frailty Indicator (TFI). J Am Med Dir Assoc 2021) ;22:607.e1-607.e6
17. Dong L, Liu N, Tian X et al (2017) Reliability and validity of the Tilburg Frailty Indicator (TFI) among Chinese community-dwelling older people. Arch Gerontol Geriatr 73:21–28
18. Hua H, Xu X, Tang Y et al (2019) Effect of sarcopenia on clinical outcomes following digestive carcinoma surgery: a meta-analysis. Support Care Cancer 27:2385–2394
19. Yang M, Luo L, Jiang J et al (2014) Development of the elderly disability assessment scale (â…¡): The selection of items for the formal version. Chinese Journal of Rehabilitation Medicine 29:212–217
20. Yang M, Luo L, Jiang J et al (2014) Quality evaluation of the elderly disability assessment scale. Chinese Journal of Rehabilitation Medicine 29:433–436
21. Meng Q, Luo J, Wan C et al (2012) Development and Evaluation on Chinese Version of Measurement Instrument of Quality of Life for Patient s with stomach Cancer: EORTC QLQ- STO22. Journal of Kunming Medical University 10:34–38
22. Tanaka T, Suda K, Inaba K et al (2019) Impact of Frailty on Postoperative Outcomes for Laparoscopic Gastrectomy in Patients Older than 80 Years. Ann Surg Oncol 26:4016–4026
23. Guo S, Zhong S, Zhang A (2013) Privacy-preserving Kruskal-Wallis test. Comput Methods Programs Biomed 112:135–145
24. Lu S, Chen F (2016) Medical Statistics. 3ndEd. China Statistics Press, China

25. Ligthart-Melis GC, Luiking YC, Kakourou A et al (2020) Frailty, Sarcopenia, and Malnutrition Frequently (Co-)occur in Hospitalized Older Adults: A Systematic Review and Meta-analysis. J Am Med Dir Assoc 21:1216–1228
26. Xu L, Pan Q, Lin R (2016) Prevalence rate and influencing factors of preoperative anxiety and depression in gastric cancer patients in China: Preliminary study. J Int Med Res 44:377–388
27. Teo N, Yeo PS, Gao Q et al (2019) A bio-psycho-social approach for frailty amongst Singaporean Chinese community-dwelling older adults - evidence from the Singapore Longitudinal Aging Study. BMC Geriatr 19:350
28. Garre-Olmo J, Calvó-Perxas L, López-Pousa S et al (2013) Prevalence of frailty phenotypes and risk of mortality in a community-dwelling elderly cohort. Age Ageing 42:46–51
29. Billot M, Calvani R, Urtamo A et al (2020) Preserving Mobility in Older Adults with Physical Frailty and Sarcopenia: Opportunities, Challenges, and Recommendations for Physical Activity Interventions. Clin Interv Aging 15:1675–1690
30. Artaza-Artabe I, Sáez-López P, Sánchez-Hernández N et al (2016) The relationship between nutrition and frailty: Effects of protein intake, nutritional supplementation, vitamin D and exercise on muscle metabolism in the elderly. A systematic review. Maturitas 93:89–99
31. Lemos MF, Lemos-Neto SV, Barrucand L et al (2019) Preoperative education reduces preoperative anxiety in cancer patients undergoing surgery: Usefulness of the self-reported Beck anxiety inventory. Braz J Anesthesiol 69:1–6
32. Daniels SL, Lee MJ, George J et al (2020) Prehabilitation in elective abdominal cancer surgery in older patients: systematic review and meta-analysis. BJS Open 4:1022–1041
33. van Rooijen S, Carli F, Dalton S et al (2019) Multimodal prehabilitation in colorectal cancer patients to improve functional capacity and reduce postoperative complications: the first international randomized controlled trial for multimodal prehabilitation. BMC Cancer 19:98
34. Liljas AEM, Carvalho LA, Papachristou E et al (2017) Self-reported vision impairment and incident prefrailty and frailty in English community-dwelling older adults: findings from a 4-year follow-up study. J Epidemiol Community Health 71:1053–1058
35. Ng N, Santosa A, Weinehall L et al (2020) Living alone and mortality among older people in Västerbotten County in Sweden: a survey and register-based longitudinal study. BMC Geriatr 20(1):7
36. Brenkman HJF, Tegels JJW, Ruurda JP et al (2018) Factors influencing health-related quality of life after gastrectomy for cancer. Gastric Cancer 21:524–532
37. Xu XY, Lu JL, Xu Q et al (2021) Risk factors and the utility of three different kinds of prediction models for postoperative fatigue after gastrointestinal tumor surgery. Support Care Cancer 29:203–211
38. Claudino MM, Lopes JR, Rodrigues VD et al (2020) Postoperative complication rate and survival of patients with gastric cancer undergoing immunonutrition: A retrospective study. Nutrition 70:110590
39. Ma L, Sun F, Tang Z (2018) Social Frailty Is Associated with Physical Functioning, Cognition, and Depression, and Predicts Mortality. J Nutr Health Aging 22:989–995
40. Fried LP, Tangen CM, Walston J et al (2001) Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 56:M146–M156
41. Gobbens RJ, van Assen MA, Luijkx KG et al (2012) The predictive validity of the Tilburg Frailty Indicator: disability, health care utilization, and quality of life in a population at risk. Gerontologist 52:619–631