Clinical Nutrition ESPEN 37 (2020) 195–201

Contents lists available at ScienceDirect

Clinical Nutrition ESPEN

journal homepage: http://www.clinicalnutritionespen.com

Original article

Nutritional status, sarcopenia, gastrointestinal symptoms and quality of life after gastrectomy for cancer – A cross-sectional pilot study

Sedegheh Gharagozlian [a, *], Tom Mala [b], Hilde Kristin Brekke [c], Lisa C. Kolbjørnsen [c], Åslaug A. Ullerud [c], Egil Johnson [b, d]

[a] Section of Clinical Nutrition, Oslo University Hospital, Ullevål, Norway
[b] Department of Pediatric and Gastrointestinal and Surgery, Oslo University Hospital, Ullevål, Norway
[c] Department of Nutrition, Institute of Basic Medical Sciences, University of Oslo, Norway
[d] Institute of Clinical Medicine, University of Oslo, Norway

ARTICLE INFO

Article history:
Received 16 November 2019
Accepted 1 March 2020

Keywords:
Gastrectomy
Malnutrition
Sarcopenia
Symptoms
Quality of life

SUMMARY

Background and aims: Gastrointestinal (GI) symptoms, malabsorption, reduced food intake and weight loss are common sequela of gastrectomy. This can result in malnutrition with a subsequent prolonged recovery, reduced physical functioning and deteriorated quality of life (QoL). Few studies have investigated the relationship between GI-symptoms, QoL and malnutrition in long-term survivors of gastric cancer. Therefore, we assess nutritional status, GI-symptoms and QoL 2–5 years after gastrectomy for malignancy.

Methods: A cross-sectional, pilot study was carried out in patients who underwent total or subtotal gastrectomy at Oslo University Hospital between 2012 and 2016, who had not experienced disease recurrence. Subjects above 85 years were excluded. The nutritional status of the patients fell into three groups by a score of subjective global assessment (SGA)-A, B, and C. Muscle mass was measured by body composition by bioelectrical impedance analysis and muscle strength was measured by handgrip strength (HGS). Dietary intake was assessed by repeated 24-h dietary recalls. GI-symptoms and QoL were assessed using GI-Symptom Rating Scale (GSRS) and the SF-36 questionnaire.

Results: 21 patients were included. Mean (SD) weight loss was 12.8% (11.6) from preoperative status to follow up. Percentage weight loss was larger after total gastrectomy compared with subtotal gastrectomy (17.9% (12.3) vs. 6.6% (7.1) ($p = 0.03$)). A low mean intake of energy and protein was reported compared to dietary recommendations for the general Nordic population and intake in a national dietary survey. All of the patients were classified as pre-sarcopenic, and 5% as sarcopenic. Persistent weight loss >10% was observed in 45% of the subjects and these were in risk of malnutrition. Subjects with malnutrition had higher GSRS score for the abdominal pain syndrome ($p = 0.042$) and lower SF-36 scores for bodily pain ($p = 0.01$) and vitality ($p = 0.02$) compared with those without malnutrition.

Conclusions: A high prevalence of weight loss, and pre-sarcopenia was observed. Malnutrition as assessed by SGA was associated with more GI-Symptoms and reduced QoL scores. Further studies with larger number of participants are needed to verify our findings.

1. Introduction

Gastric cancer is the fifth most common cancer and the third leading cause of cancer death worldwide [1,2]. The highest incidence rates are in Eastern and Central Asia and Latin America. There has been a steady decline in gastric cancer incidence rates over the last few decades [1,2]. According to the Cancer Registry of Norway, 392 individuals were diagnosed with gastric cancer in 2018 [3]. Overall five-year survival after total or partial gastrectomy as curative treatment of gastric cancer in Norway has recently been 40–42% [4]. Total gastrectomy, removal of the entire stomach, is widely used as surgical treatment for gastric cancer. Gastrectomy

* Corresponding author. Section of Clinical Nutrition, Oslo University Hospital HF, Postboks 4950 Nydalen, 0424 Oslo, Norway.
E-mail address: sedgha@ous-hf.no (S. Gharagozlian).

https://doi.org/10.1016/j.clnesp.2020.03.001

Abbreviations

ASM	Appendicular skeletal muscle mass
ASMI	Appendicular skeletal muscle mass index
BIA	Bioelectrical impedance analysis
BMI	Body mass index
BMR	Basal metabolic rate
CI	Confidence interval
COPD	Chronic obstructive pulmonary disease
EWGSOP	European Working Party on Sarcopenia in Older People
FM	Fat mass
FFM	Fat free mass
GI-symptoms	Gastro-intestinal symptoms
GSRS	Gastrointestinal Symptom Rating Scale
HGS	handgrip strength
IBD	Inflammatory bowel disease
IQR	interquartile range
Kilojoule	kJ
OUH	Oslo University Hospital
PAL	physical activity level
QOL	Quality of life
SD	standard deviation
SGA	Subjective global assessment
SF-36	Short form-36 (evaluation of quality of life)
SG	Subtotal gastrectomy
TEE	Total energy expenditure
TG	Total gastrectomy
WL	weight loss
WHO	World Health Organization

results in risk of gastrointestinal symptoms (GI-symptoms) such as dumping, pain, nausea, vomiting, diarrhea, reflux, lowered food intake and weight loss [5–9]. The anatomic alterations in the GI-tract after gastrectomy can also affect the patient's ability to consume, digest and absorb nutrients, which further deteriorates nutritional status.

Malnutrition refers to the imbalance between intake of nutrients and requirements that ultimately induces changes in body weight, body composition, and physical function [10,11]. Low muscle mass is part of the definition of malnutrition [11]. Malnutrition, an independent factor for impaired quality of life (QoL), is frequently observed in patients with gastric cancer [8,12]. Aspects of QoL have been reported strongly correlated to malnutrition assessed by the Subjective Global assessment (SGA), body mass index (BMI) and percentage weight loss [13].

As the survival rate of patients after gastrectomy has improved, [14] long-term QoL will be of major concern. Thus the most important aspect of post-treatment monitoring may be for nutritional sequela and management of GI-symptoms [15]. Aspects of QoL will be changed following gastrectomy for cancer [5]. However, few studies have explored the interactions between GI-symptoms and QoL with respect to weight loss and malnutrition after gastrectomy in long-term survivors. To date, the main purpose of follow-up after gastrectomy for gastric cancer has been surveillance for recurrent disease [15]. However, available recommendations for nutritional and symptomatic follow-up of these patients are limited. To our knowledge, no studies have assessed nutritional status, GI-symptoms and QoL related to malnutrition amongst Norwegian patients radically treated for gastric cancer. The main aims of this study were to evaluate the prevalence of malnutrition and the relationship between malnutrition and GI-symptoms and QoL 2–5 years after gastrectomy for cancer in a Norwegian pilot cohort.

2. Patients and methods

This cross-sectional pilot study was conducted at Oslo University Hospital, Ullevål between 2012 and 2016. The institution is a regional referral center for surgical treatment of gastric cancer. Subjects with gastric cancer without metastatic disease that underwent curative resection by total- or subtotal (removal of lower part of the stomach) gastrectomy, were eligible for study enrollment. Exclusion criteria were a travel distance more than 2 h away from the study location, age above 85 and insufficient Norwegian language skills to conduct a phone conversation without an interpreter.

Anthropometric measures including weight, height, BMI were performed. The BMI cut-off values were defined according to the World Health Organization (WHO) [16]. Preoperative weight was collected from the medical journals on the day of operation, and in cases in cases without such data, the participants were asked about weight at the examination. Total weight loss was calculated based on the preoperative weight and the weight measured at the study consultation using the equation ((preoperative weight (kg) – current weight (kg))/preoperative weight (kg))*100.

Body composition was measured using a body impedance appliance (BIA), Seca Medical Body Composition Analyzer 515 (Seca GmbH & Co. KG, Hamburg, Germany), and assessed as previously described [17]. Sarcopenia was defined as the presence of both low muscle mass and muscle strength or impaired physical performance as recommended by the European Working Group on Sarcopenia in Older People (EWGSOP) [18]. Appendicular skeletal muscle mass index (ASMI), the index of sarcopenia, was estimated by dividing the total mass of the 4 limbs by the square of the height; (ASM/height^2). Low muscle mass was classified as ASMI less than 7.0 kg/m^2 and 5.5 kg/m^2 in men and women, respectively. Muscle strength was assessed by handgrip strength (HGS), measured using a Grip Strength dynamometer (T.K.K 5401 Grip-D, Takei Scientific Instruments co. ltd, Japan). Subjects were instructed to stand upright in a comfortable position with both arms lowered. Measurements were performed twice with the right and left hand alternately. The mean value of the largest force measured for each hand was computed. The generated force was measured to the closest 0.1 kg [19]. Low muscle strength was defined as a HGS <27 kg or <16 kg for males and females, respectively [18].

The nutritional status was evaluated by the score of SGA [21] that defines three categories: SGA-A: well nourished, SGA-B: moderate malnutrition, SGA-C: severe malnutrition. Nutrition assessment parameters include a medical history (weight, dietary intake, GI symptoms, and functional capacity) and physical examination.

The 24-h dietary recall was repeated three times for each participant. The first interview was conducted during the consultation. The participants were asked to recall all the foods and beverages they consumed the preceding day. At the end of the interview, the participants were asked about additional foodstuffs from a list of easily overlooked items, such as snacks, cakes, pastry and alcoholic beverages. The participants were also asked if they consumed dietary supplements, and the brands, doses and frequencies were registered. The second and the third interviews were performed as telephone interviews within a few months after the first recall. One weekday and one weekend day were randomly

selected to obtain a representative selection of the participants' habitual diets. Picture booklets were distributed to bring home, in order to simplify the quantification of portion sizes of the foods and beverages they had consumed. The dietary intakes were estimated using the software program Dietist Net, version 17.08.22 (Kost och Näringsdata AB, Bromma, Sweden). The mean of the registered intake from the three days was used in further analyses. Basal metabolic rate (BMR) was calculated using the Schofield's equation. The BMR was then multiplied with the physical activity level (PAL) 1.6 to estimate the participants' total energy expenditure (TEE). For each participant, the total energy intake (TEI) was compared with TEE, and the percentage of TEI to TEE was calculated.

The Gastrointestinal Symptom Rating Scale (GSRS) is a validated self-administered disease-specific questionnaire that includes 15 items categorized into five symptom clusters addressing different GI symptoms; reflux, abdominal pain, indigestion, diarrhea and constipation [20,21]. As normative Norwegian data were not available, GI-symptom scores were compared to normative data collected in the neighboring Swedish population for the age group 60–69 years [22]. Comparisons were made both as a total and separated by sex. A difference in GSRS scale score of 0.5 points or more were considered clinically relevant [23].

QoL was evaluated using the Short Form 36 (SF-36) [24]. It constitutes 36 items that can be structured into eight main scales: Physical functioning, Role-physical, Bodily Pain, General Health, Vitality, Social functioning, Role-emotional, and Mental Health. The scale scores range from 0 (the poorest) to 100 (optimal) [24]. Study scores were compared to normative data from the Norwegian population, aged 60–69 years, both as a total and separated by sex. A difference in QoL scale $\geq$5 points scores were considered clinically relevant. The SF-36 Health Survey Manual and Interpretation Guide protocol was used for handling missing items [24].

The study was approved by the Regional Ethics Committee, (2016/1471 REK sør-øst D), and written informed consent was obtained from each patient prior to any study procedures.

3. Statistics

For demographic variables mean values, standard deviation (SD) or percentages are given. Due to skewed distribution of several variables, median, interquartile range (IQR), min and max are given when appropriate. Categorical variables were tested with the X2 test, or with the Fisher's Exact test when assumptions for the X2 test were violated. The One-Sample t-test was used to compare a study population means with a known normative mean. The Sign test was used for non-normally distributed variables. The Sign test allows comparison of the study sample median to the population norm without assumptions of normal distribution or symmetrical data. Statistical significance of $p < 0.05$ was assumed. IBM statistics, SPSS Inc. Chicago SPSS, Inc, Chicago IL, Version 24.0 was used for the statistical analyses.

4. Results

For an overview of the recruitment process see Fig. 1. Participation rate amongst eligible subjects was 60%. In total 21 patients were enrolled and their demographic data are presented in Table 1. Mean (SD) time passed since surgery at the study consultation was 28.7 (8.3) months. Total gastrectomy was performed in 52% of the patients. The one subject without a Roux-en-Y reconstruction, had a gastroesophageal resection with an intrathoracic oesophagogastric anastomosis. Neoadjuvant or adjuvant chemotherapy was administered to 81% of the subjects. Approximately half of the subjects (57%) consulted a dietician before surgery, and 86% received such follow-up in hospital postoperatively.

Measures of malnutrition are described in Table 2. According to the SGA method, fifteen subjects (72%) received the SGA score A, and were considered well-nourished. Five subjects (24%) received the SGA score B, and were thus identified as moderately malnourished or suspected of being malnourished. One subject (5%) was classified as SGA-C, which corresponded to being severely malnourished.

The study population had a mean (SD) decline of 4.0 [4] BMI units from preoperative status to the study consultation, ranging between an increase of 1.0 unit to a decrease of 18.8 units (Fig. 2). The study population had a mean (SD) maximum percentage weight loss of 17.6 [12] % after gastrectomy, ranging from 0.8% to 46.4%. At the time of study consultation visit, only one of the participants had regained preoperative weight, while the other subjects had persistent weight loss. Body weight changes from preoperative status to the study consultation ranged from gaining 4.9% to losing 43.4%. Mean (SD) percentage weight loss at the study consultation was 12.8 [12] %. Nine (45%) subjects has persistent weight loss of >10% at the study consultation. These individuals had a significantly higher preoperative BMI of 29.3 (4.4) kg/m^2 compared to 23.4 (3.3) kg/m^2 for those who had a weight loss $\leq$10% ($p = 0.003$). There was a significantly higher proportion of individuals with TG amongst those with >10% weight loss ($p = 0.009$). The group with subtotal gastrectomy had regained more weight and had a mean (SD) weight loss of 6.6 (7.1) %, while those who had total gastrectomy had a mean weight loss of 17.9 (12.3) % ($p = 0.03$). Subjects with >10% weight loss also had a significantly lower age of 56.8 (9.5) years, compared to 70.3 (8.1) years ($p = 0.003$) for those with $\leq$10% weight loss.

Sex-specific low ASMI ($\leq$7.0 kg/m^2 in men and $\leq$5.5 kg/m^2 in women) was observed in all individuals, who then by definition were pre-sarcopenic. Low muscle function (<27 kg in men and <16 kg in women) was observed in 5% of women (one patient out of 20), and was sarcopenic based on cut off values of ASMI and HGS.

Mean (SD) energy intake was 6671 (1802) kilojoule (kJ). Study subjects ingested on average 119.6 (39.5) % of their energy expenditure (kJ) based on BMR. However, eight subjects (39%) did not have sufficient energy intake to match their BMR. Based on TEE subjects ingested mean (SD) 74.8 [25] % of their energy requirement (kJ) (PAL 1.6). Protein intake was mean (SD) 67.6 [23] grams, which gives a protein intake of mean (SD) 107.6 (45) % of the lower recommended requirement of one gram protein per kg body weight per day. However, 11 individuals (52%) did not meet the lowest recommended protein requirement.

Subjects with malnutrition scored higher GSRS scores on the abdominal pain syndrome than well-nourished patients ($p = 0.042$) (Table 3). Mean GSRS total score tended towards being statistically higher for subjects with malnutrition ($p = 0.055$). Subjects with >10% weight loss scored clinically significant higher by 5 or more points for diarrhea and reflux in addition to total GSRS score. Bodily pain and vitality SF-36 scores were significantly lower for subjects with malnutrition compared to well-nourished subjects ($p = 0.015$ and $p = 0.021$ respectively) (Table 4). Subjects with malnutrition had clinically relevant lower scores for all SF-36 scales, except for mental health where they scored higher.

5. Discussion

Gastrectomy as curative treatment of gastric cancer leads to persisting weight loss and malnutrition and impaired QoL [9,20,25–27]. We found that malnutrition was mild to moderate in 23.8% and severe in 4.4% of subjects. Thus, severe malnutrition was less frequent than reported by Ryu & Kim [28]. However, the fact that SGA focused on recent weight loss assessment closer to surgery, could have contributed to a higher proportion of subjects

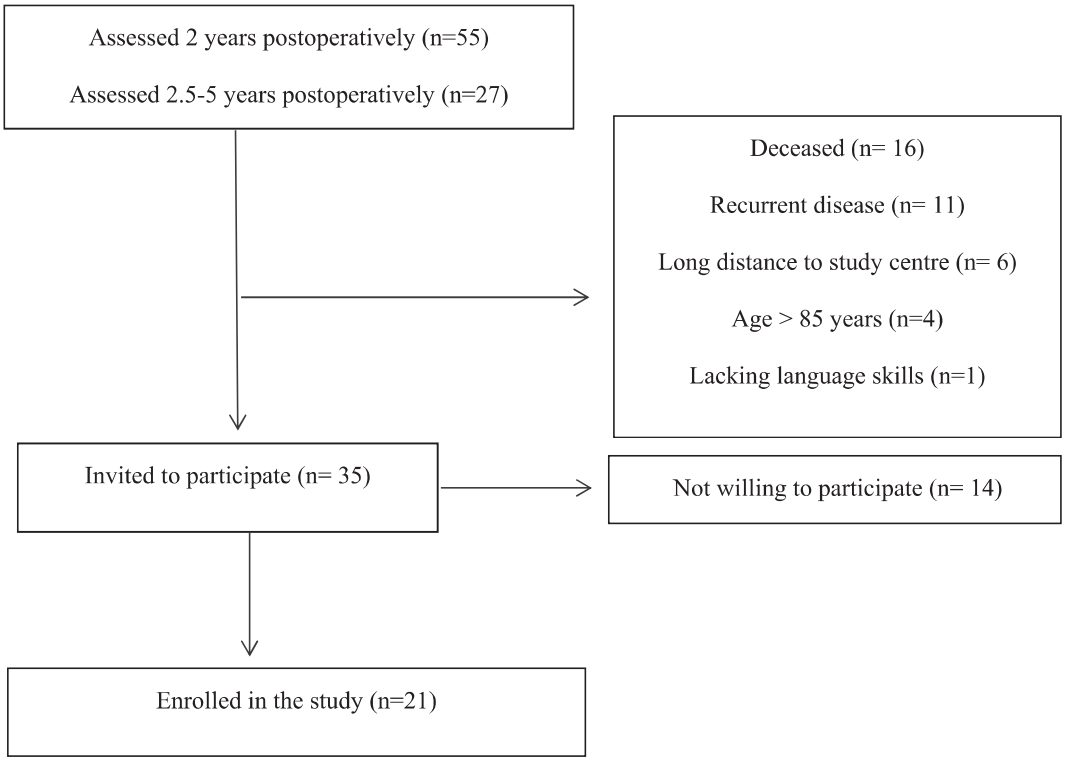

Fig. 1. Flow chart of study participant recruitment after gastrectomy for cancer. Mean (SD) follow up was 28.7 (8.3) months.

Table 1
Characteristics of 21 patients having undergone gastrectomy for cancer. Mean (SD) follow up was 28.7 (8.3) months.

	n (%)
Gender	
Female	10 (48)
Male	11 (52)
Ethnicity (mean, SD)	60 (12.6)
Asian	2 (10)
Caucasian	19 (90)
Age at surgery (years) (mean, SD)	60 (12.6)
Preoperative BMI (kg/m^2) (mean,SD)	26.0 (4.8)
Type of surgery	
Subtotal gastrectomy	10 (48)
Total gastrectomy	11 (52)
Surgical reconstruction	
Roux-en-Y	20 (95.2)
Oesophagogastric	1 (4.8)
Cancer stage[a]	
I	9 (42.9)
II	8 (38.1)
III	4 (19.0)
Chemotherapy	
Yes	17 (81)
No	4 (190
Contact with clinical nutritionist	
Before surgery	12 (57.1)
After surgery (in hospital)	18 (85.7)
Body composition (mean, SD)	
FM	28.0 (11.0)
FFM	46.4 (10.8)
Comorbidities at follow up	
Myocardial infarction	3 (14.3)
Cerebrovascular	3 (14.3)
Diabetes	1 (4.8)
IBD	1 (4.8)
COPD	1 (4.8)

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; IBD, inflammatory bowel disease; SD, standard deviation; SGA, subjective global assessment.
[a] Tumor stage determined from surgical specimen and preoperative evaluation.

Table 2
Measures of malnutrition in 21 patients after gastrectomy for cancer. Mean (SD) follow up was 28.7 (8.3) months.

	Value	Measure
Subjective Global Assessment		
(ratio A:B:C)[a]	15:5:1	n
BMI current[b] (kg/m^2)	22.2 (3.3)	Mean (SD)
BMI <18.5 (kg/m^2)	2 (10.0)	n (%)
Percentage weight change max[c] (%)	17.6 (11.8)	Mean (SD)
Percentage weight change total[b] (%)	12.8 (11.6)	Mean (SD)
>10% weight loss current[b]	9 (45)	n (%)
ASMI		
Females (kg/m^2)	3.2 (0.60)	Mean (SD)
Males (kg/m^2)	4.4 (0.51)	Mean (SD)
Handgrip strength		
Females (kg)	23.6 (5.5)	Mean (SD)
Males (kg)	43.1 (9.3)	Mean (SD)
Presarcopenia[d]	20 (100.0)	n (%)
Sarcopenia[e]	1 (5.0)	n (%)

n = 20 for current BMI, low BMI, current percentage weight change, SMI and evaluation of sarcopenia.
[a] A: well nourished, B: mildly or moderately malnourished, and C: severely malnourished.
[b] Calculations based on weight measured at study consultation.
[c] Percentage weight change based on lowest measured weight after surgery.
[d] Presarcopenia defined as low SMI <7.0 kg/m^2 for males and <5.5 kg/m^2 for females, Appendicular skeletal muscle mass index (ASMI), the index of sarcopenia, was calculated by dividing the total mass of the 4 limbs by the square of the height; (ASM/height^2), Sarcopenia defined as low SMI in combination with low handgrip strength, <27 kg for males and <16 kg for females.
[e] Abbreviations: SD, standard deviation, BMI, body mass index, SMI, skeletal muscle index.

classified as malnourished. Moreover, Ryu et al. [28], using SGA assessment at 6 and 12 months postoperatively found that twelve month after gastrectomy most of the subjects earlier identified as malnourished were classified as well-nourished. However, it

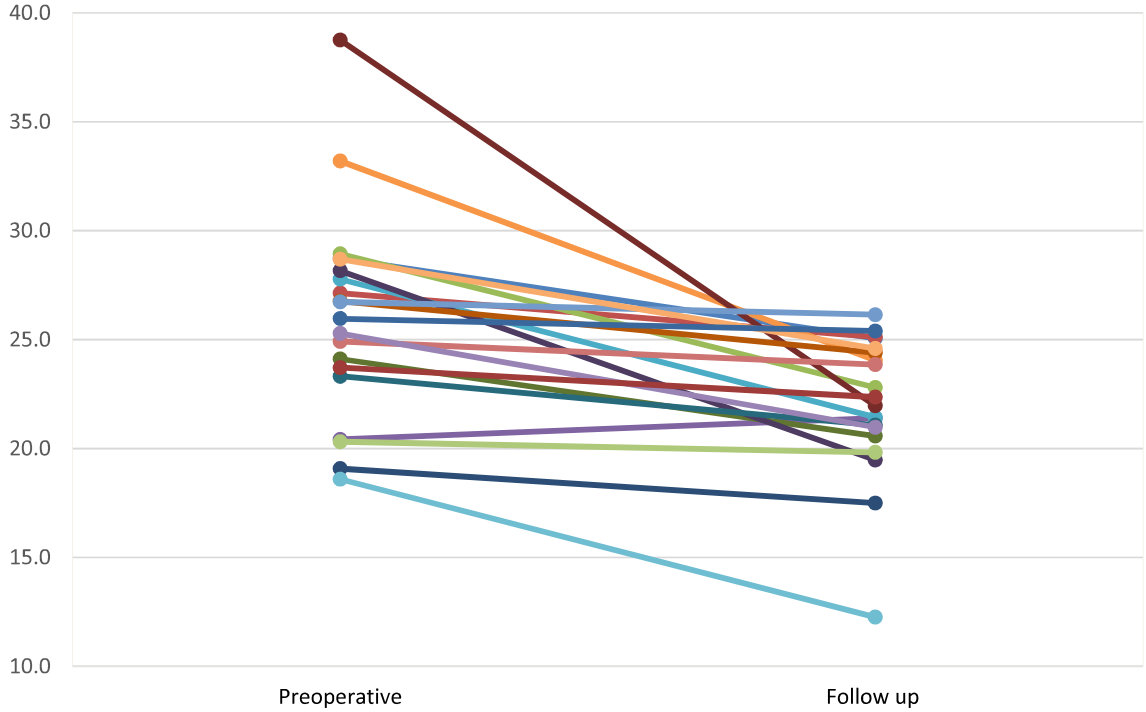

Fig. 2. Changes in body mass index (BMI) from preoperative to study consultation in 20 patients operated with gastrectomy for cancer. Y-axis represents BMI units (kg/m^2). Each line represents one individual (n = 20), one study participant (pregnant) excluded. Mean (SD) follow up was 28.7 (8.3) months.

Table 3
Comparison of gastrointestinal symptoms between subjects with no malnutrition (n = 15) and subjects with mild, moderate or severe malnutrition (n = 6), assessed by SGA.

GSRS Syndrome	Well-nourished Median (IQR)	Malnourished[a] Median (IQR)	Well-nourished Mean (SD)	Malnourished[a] Mean (SD)	p-value[b]
Abdominal pain†	2.0 (1.3)	3.2 (1.4)	2.0 (0.88)	2.9 (0.72)	0.042*
Diarrhea	1.7 (1.3)	2.5 (2.2)	2.3 (1.5)	2.6 (1.3)	0.47
Constipation	1.3 (1.3)	3.0 (2.9)	1.8 (0.84)	2.9 (1.4)	0.1
Indigestion†	2.8 (1.3)	3.5 (0.69)	2.9 (1.0)	3.5 (0.43)	0.23
Reflux	1.0 (1.0)	1.8 (2.8)	1.5 (0.97)	2.3 (1.4)	0.18
Total score†	1.8 (0.90)	2.9 (0.77)	2.1 (0.79)	2.8 (0.54)	0.055

*Significant difference p < 0.05.
Abbreviations: CI, confidence interval; IQR, interquartile range.
[a] Malnourished includes SGA categories B (mild or moderate malnutrition) and C (severe malnutrition).
[b] Differences tested with independent sample t-test (variables marked with †, indicating normal distribution) or Mann–Whitney U test.

Table 4
Comparison of SF-36 quality of life scores between subjects with no malnutrition (n = 15) and subjects with moderate or severe malnutrition (n = 5) after gastrectomy for cancer, assessed by SGA.

SF-36 Scale	Well-nourished[a] Median (IQR)	Malnourished[b] Median (IQR)	Well-nourished[a] Mean (SD)	Malnourished[b] Mean (SD)	p-value[c]
Physical functioning	85.0 (25.0)	70.0 (37.5)	79.3 (22.1)	63.0 (22.5)	0.14
Role-physical	100.0 (100.0)	25.0 (62.5)	60.0 (46.1)	30.0 (25.0)	0.31
Bodily pain	84.0 (39.0)	41.0 (25.5)	79.2 (22.0)	47.6 (13.7)	0.015*
General health†	70.0 (45.0)	60.0 (57.0)	66.0 (21.9)	52.8 (28.9)	0.29
Vitality†	50.0 (40.0)	30.0 (40.0)	54.7 (24.3)	24.0 (20.4)	0.021*
Social functioning	75.0 (50.0)	75.0 (50.0)	75.0 (24.6)	70.0 (33.8)	0.87
Role-emotional	100.0 (66.7)	66.7 (100.0)	64.4 (42.7)	53.3 (50.6)	0.61
Mental health†	76.0 (32.0)	80.0 (16.0)	73.9 (20.9)	80.0 (10.1)	0.54

*Significant difference p <0.05.
Abbreviations: IQR, interquartile range, SD; standard deviation; SGA, Subjective Global Assessment.
[a] Well-nourished indicates SGA category A.
[b] Malnutrition indicates SGA categories B (mild or moderate malnutrition) and C (severe malnutrition).
[c] Differences tested with independent sample t-test (variables marked with †, indicating normal distribution) or Mann–Whitney U test.

cannot be ruled out that subjects considered well-nourished according to SGA were in fact malnourished due to confounding factors such as a substantial and involuntarily persisting weight loss that occurred more than six months earlier and loss of muscle mass that could not be detected by physical examination. In our study, subjects with malnutrition had significantly lower vitality scores than the well-nourished. This is consistent with previous research [13,20], that show impairments in physical function and general health amongst subjects with malnutrition. Subjects with malnutrition had also more severe GI-symptoms than those without malnutrition. Only abdominal pain score was statistically significantly higher for the malnourished subjects, but all GSRS scores were higher to a degree of clinical significance. Lim et al. compared QoL and GI-symptoms between subjects categorized by the SGA using the QLQ-C30 and STO22. They found that the well-nourished scored significantly better for pain, nausea and reflux [13]. Carey et al. assessed QoL and symptoms in relation to SGA status after upper gastrointestinal surgery, using the QLQ-C30 and GSRS. Significant differences were observed between subjects classified as SGA-A and SGA-C for appetite, nausea and vomiting [20].

Our results demonstrated a 12.8% total weight loss at mean follow up of 29 months. Previous studies have reported total weight loss of 10–15% in the early postoperative phase [29,30]. In the long term permanent weight loss of 8.3–13.6% has been reported [7,31,32]. We observed that 45% of the patients had a persistent weight loss of >10% at follow up, which is consistent with previous findings, where 67% of subjects had >10% weight loss at two years postoperatively [12]. Climnet et al. [12] explored the association between QoL and weight loss in patients before and 2 years after surgery. They found that disabling symptoms were more common in patients with ≥10% versus <10% body weight loss, with a relevant negative impact on health related quality of life [12]. In accordance with previous studies [32,33], we found that the subjects with a high preoperative BMI (>25 kg/m^2) had a significantly larger postoperative weight loss (18%) than those with BMI 20–25 kg/m^2 (6%). The higher prevalence of symptoms in the >10% weight loss group highlights the importance of individual follow up to address persistent symptoms and hinder that they lead to further compromised nutritional state.

In the current study, the prevalence of low muscle mass and pre-sarcopenia was 100%. Heneghan et al. found a slightly lower prevalence (81%) of subjects with low muscle mass at 18–24 months postoperatively [9]. Combined low muscles mass and muscle strength were present in 5% of our study subjects and thus defined as sarcopenic [18]. A meta-analysis on sarcopenia in gastric cancer patient undergoing gastrectomy found a prevalence of 5–13% in patients aged 60–70 years. Studies reporting on sarcopenia use different techniques and cut-off values that may contribute to the observed differences in prevalence and impact on postoperative outcomes [34].

Inadequate protein intake is a risk factor for developing sarcopenia [35]. In our study, 11 individuals (52%) did not meet their lower recommended protein requirement of 1 g/kg body weight per day. Subjects above 65 years have an increased need for protein [36]. This is of special importance when food intake decreases below 8000 kJ [36]. Dietary intake of 1.2–1.5 g/kg of protein may prevent sarcopenia [37]. However, 24-h recalls are prone to measurement error associated with memory and the challenge of estimating quantities of foods and beverages. Additionally, underreporting of energy intakes may consciously occur due to a desire to present oneself positively, resulting in so-called social desirability bias. Underreporting has been shown to be especially common in overweight or obese populations, which did not characterize the study sample of the present study [38]. Thus, a lower degree of underreporting may be expected in the study sample. This was supported by the fact that several of the participants expressed concern that they were not able to eat as much as they wanted to or felt that they needed. Our results emphasize the need for nutritional follow up regarding energy- and protein intake, also long term after a gastrectomy.

Several authors have called for a review of the contemporary follow up regimes after gastrectomy, with special attention to nutritional status [20,39]. Weight monitoring and evaluation by a dietician including multidisciplinary preoperative assessment, patient education and management of postoperative symptoms in the short and long term have been suggested [7].

Limitations of our study are the cross-sectional single center study design with a small sample size that preclude reasonable sub-analyses to be made and a risk of type II statistical bias. Findings should thus be interpreted with caution. Another limitation is the possibility of under- or over reporting to questionnaires. Change in quality and quantity of food intake is challenging to evaluate, based on the information provided by the patient. Despite these limitations, to the best of our knowledge, this is the first study in Norway exploring nutritional status, GI-symptoms and QoL in relation to malnutrition amongst survivors of gastric cancer. A study strength is the use of EWGSOP recommendations to diagnose sarcopenia. The broad comprehensive individual evaluation performed also represents strength of the study.

In conclusion, we observed a high prevalence of weight loss >10%, and pre-sarcopenia following gastrectomy for cancer. Malnutrition in these patients may be associated with more GI-symptoms and reduced SF-36 scores. Further research is needed on long term, postoperative nutritional follow up in this patient group to address the persistent weight loss and GI-symptoms, and possibly improve QoL.

6. Founding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

7. Author contribution

Sedegheh Gharagozlian designed the study, researched data and drafted the manuscript.

Tom Mala and Egil Johnson designed the study and researched data.

Lisa C. Kolbjørnsen, Åslaug A. Ullerud performed clinical assessments and researched data.

Hilde Kristin Brekke researched data.

All authors participated in manuscript writing, review, editing and discussion and have read and approved the final version.

Declaration of Competing Interest

The authors state that they have no conflicts of interest.

Acknowledgment

The authors wish to thank the Nutrition Outpatient Clinic at Oslo University Hospital, Rikshospitalet for making rooms available for the study consultations and for providing equipment employed for data collection.

References

[1] Sitarz R, Skierucha M, Mielko J, Offerhaus GJA, Maciejewski R, Polkowski WP. Gastric cancer: epidemiology, prevention, classification, and treatment. Cancer Manag Res 2018;10:239–48.

[2] Rawla P, Barsouk A. Epidemiology of gastric cancer: global trends, risk factors and prevention. Przegląd Gastroenterol 2019;14(1):26–38.

[3] Norway CRo. Cancer in Norway 2018. 2019. Available from: https://www.kreftregisteret.no/Generelt/Rapporter/Cancer-in-Norway/cancer-in-norway-2018/.

[4] Bringeland EA, Wasmuth HH, Fougner R, Mjones P, Gronbech JE. Impact of perioperative chemotherapy on oncological outcomes after gastric cancer surgery. Br J Surg 2014;101(13):1712–20.

[5] Karanicolas PJ, Graham D, Gonen M, Strong VE, Brennan MF, Coit DG. Quality of life after gastrectomy for adenocarcinoma: a prospective cohort study. Ann Surg 2013;257(6):1039–46.

[6] Adams JF. The clinical and metabolic consequences of total gastrectomy. I. Morbidity, weight, and nutrition. Scand J Gastroenterol 1967;2(2):137–49.

[7] Davis JL, Ripley RT. Postgastrectomy syndromes and nutritional considerations following gastric surgery. Surg Clin 2017;97(2):277–93.

[8] Nourissat A, Vasson MP, Merrouche Y, Bouteloup C, Goutte M, Mille D, et al. Relationship between nutritional status and quality of life in patients with cancer. Eur J Cancer (Oxf Engl) 2008;44(9):1238–42.

[9] Heneghan HM, Zaborowski A, Fanning M, McHugh A, Doyle S, Moore J, et al. Prospective study of malabsorption and malnutrition after esophageal and gastric cancer surgery. Ann Surg 2015;262(5):803–7. discussion 7-8.

[10] Cederholm T, Jensen GL. To create a consensus on malnutrition diagnostic criteria. JPEN 2017;41(3):311–4.

[11] Cederholm T, Jensen GL, Correia M, Gonzalez MC, Fukushima R, Higashiguchi T, et al. GLIM criteria for the diagnosis of malnutrition – a consensus report from the global clinical nutrition community. Clin Nutr (Edinb Scotl) 2019;38(1):1–9.

[12] Climent M, Munarriz M, Blazeby JM, Dorcaratto D, Ramon JM, Carrera MJ, et al. Weight loss and quality of life in patients surviving 2 years after gastric cancer resection. Eur J Surg Oncol 2017;43(7):1337–43.

[13] Lim HS, Cho GS, Park YH, Kim SK. Comparison of quality of life and nutritional status in gastric cancer patients undergoing gastrectomies. Clin Nutr Res 2015;4(3):153–9.

[14] Arnold M, Rutherford MJ, Bardot A, Ferlay J, Andersson TM, Myklebust TA, et al. Progress in cancer survival, mortality, and incidence in seven high-income countries 1995-2014 (ICBP SURVMARK-2): a population-based study. Lancet Oncol 2019 Nov;20(11):1493–505.

[15] Takahashi S, Shimizu S, Nagai S, Watanabe H, Nishitani Y, Kurisu Y. Characteristics of sarcopenia after distal gastrectomy in elderly patients. PloS One 2019;14(9):e0222412.

[16] Organization WH. Obesity: preventing and managing the global epidemic. Report of a WHO consultation (WHO Technical Report Series 894). 2000.

[17] Kyle UG, Bosaeus I, De Lorenzo AD, Deurenberg P, Elia M, Gomez JM, et al. Bioelectrical impedance analysis – part I: review of principles and methods. Clin Nutr (Edinb Scotl) 2004;23(5):1226–43.

[18] Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyere O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing 2019;48(1):16–31.

[19] Bibiloni MDM, Karam J, Bouzas C, Aparicio-Ugarriza R, Pedrero-Chamizo R, Sureda A, et al. Association between physical condition and body composition, nutrient intake, sociodemographic characteristics, and lifestyle habits in older spanish adults. Nutrients 2018;10(11).

[20] Carey S, Storey D, Biankin AV, Martin D, Young J, Allman-Farinelli M. Long term nutritional status and quality of life following major upper gastrointestinal surgery – a cross-sectional study. Clin Nutr (Edinb Scotl) 2011;30(6):774–9.

[21] Olsson U, Bosaeus I, Svedlund J, Bergbom I. Patients' subjective symptoms, quality of life and intake of food during the recovery period 3 and 12 months after upper gastrointestinal surgery. Eur J Cancer Care 2007;16(1):74–85.

[22] Dimenas E, Carlsson G, Glise H, Israelsson B, Wiklund I. Relevance of norm values as part of the documentation of quality of life instruments for use in upper gastrointestinal disease. Scand J Gastroenterol Suppl 1996;221:8–13.

[23] Norman GR, Sloan JA, Wyrwich KW. Interpretation of changes in health-related quality of life: the remarkable universality of half a standard deviation. Med Care 2003;41(5):582–92.

[24] Ware JE. SF-36 health survey manual and interpretation guide. 1993. Available from, https://www.optum.com/solutions/life-sciences/answer-research/patient-insights/sf-health-surveys.html?s=PPC&pstc=optum:ppc:LS_4.1_2018:g:ls:Frm:18wd1fk01rr23&ppcid=sf%2036&adid=247796573515&adgroupid=51056682455&campaignid=1036340767&o=optum:ppc:LS_4.1_2018:frm:ls:Frm:18wd1fk01rr23&gclid=EAIaIQobChMIj_PZ55rf4wIVFtKyCh02ZAn4EAAYASAAEgKJzfD_BwE.

[25] Park KB, Park JY, Lee SS, Kwon OK, Chung HY, Yu W. Impact of body mass index on the quality of life after total gastrectomy for gastric cancer. Cancer Res Treat 2018;50(3):852–60.

[26] Seo HS, Jung YJ, Kim JH, Park CH, Kim IH, Lee HH. Long-term nutritional outcomes of near-total gastrectomy in gastric cancer treatment: a comparison with total gastrectomy using propensity score matching analysis. J Gastric Cancer 2018;18(2):189–99.

[27] Park KB, Yu B, Park JY, Kwon OK, Yu W. Impact of body mass index on quality of life after distal gastrectomy for gastric cancer. Ann Surg Treat Res 2019;96(5):250–8.

[28] Ryu SW, Kim IH. Comparison of different nutritional assessments in detecting malnutrition among gastric cancer patients. World J Gastroenterol 2010;16(26):3310–7.

[29] Bae JM, Park JW, Yang HK, Kim JP. Nutritional status of gastric cancer patients after total gastrectomy. World J Surg 1998;22(3):254–60. discussion 60-1.

[30] Liedman B, Andersson H, Bosaeus I, Hugosson I, Lundell L. Changes in body composition after gastrectomy: results of a controlled, prospective clinical trial. World J Surg 1997;21(4):416–20. discussion 20-1.

[31] Lee SS, Yu W, Chung HY, Kwon OK, Lee WK. Using quality of life scales with nutritional relevance after gastrectomy: a challenge for providing personalized treatment. J Gastric Cancer 2017;17(4):342–53.

[32] Tanabe K, Takahashi M, Urushihara T, Nakamura Y, Yamada M, Lee SW, et al. Predictive factors for body weight loss and its impact on quality of life following gastrectomy. World J Gastroenterol 2017;23(26):4823–30.

[33] Davis JL, Selby LV, Chou JF, Schattner M, Ilson DH, Capanu M, et al. Patterns and predictors of weight loss after gastrectomy for cancer. Ann Surg Oncol 2016;23(5):1639–45.

[34] Shen Y, Hao Q, Zhou J, Dong B. The impact of frailty and sarcopenia on postoperative outcomes in older patients undergoing gastrectomy surgery: a systematic review and meta-analysis. BMC Geriatr 2017;17(1):188.

[35] Fukuda Y, Yamamoto K, Hirao M, Nishikawa K, Nagatsuma Y, Nakayama T, et al. Sarcopenia is associated with severe postoperative complications in elderly gastric cancer patients undergoing gastrectomy. Gastric Cancer 2016;19(3):986–93.

[36] Ministers NCo. Nordic nutrition recommendations. 5th ed. 2012 Available from: https://www.norden.org/no/node/7832.

[37] Morley JE. Sarcopenia: diagnosis and treatment. J Nutr Health Aging 2008;12(7):452–6.

[38] Subar AF, Freedman LS, Tooze JA, Kirkpatrick SI, Boushey C, Neuhouser ML, et al. Addressing current criticism regarding the value of self-report dietary data. J Nutr 2015;145(12):2639–45.

[39] Zhang L, Lu Y, Fang Y. Nutritional status and related factors of patients with advanced gastrointestinal cancer. Br J Nutr 2014;111(7):1239–44.