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Original Article

Nutritional status and postoperative outcomes in patients undergoing major resection for gastrointestinal cancer: a prospective cohort study

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Abstract

Malnutrition is highly prevalent among patients with gastrointestinal (GI) cancers and has a significant effect on surgical outcomes. Despite the growing recognition of this relationship, standardized nutritional assessment and intervention protocols remain inconsistent across healthcare settings. A prospective cohort study was carried out over a one-year period (June 2023–June 2024) to determine the associations between preoperative nutritional status and postoperative outcomes in patients undergoing major resection for GI malignancies. Consecutive patients who underwent elective major GI cancer resection were enrolled. The study utilized validated tools to assess nutritional status, including serum albumin (ALB), body mass index (BMI), and the Patient-Generated Subjective Global Assessment (PG-SGA). The principal outcomes were major postoperative complications (Clavien–Dindo grade ≥ 3), length of hospital stay, and thirty-day mortality. Among 294 patients, 128 (43.5%) were identified as nutritionally at risk preoperatively. Patients classified as malnourished experienced significantly higher 30-day mortality, with a rate of 12.5% versus 4.2% in well-nourished patients ($p = 0.008$). They also had a greater incidence of major postoperative complications, occurring in 35.9% of cases versus 18.1% among their well-nourished counterparts ($p < 0.001$). In addition, the median length of hospital stay was notably longer in malnourished individuals (14 days) than in those with adequate nutritional status (9 days; $p < 0.001$). Multivariate analysis revealed severe malnutrition as an independent risk factor for adverse postoperative outcomes, with an odds ratio (OR) of 2.84, a 95% confidence interval (CI) ranging from 1.52–5.31, and a p value of 0.001. These findings demonstrate that preoperative malnutrition significantly increases perioperative morbidity and mortality among patients undergoing GI cancer surgery. These findings advocate the integration of routine nutritional screening and tailored interventions into the perioperative care pathway.

Keywords

Gastrointestinal neoplasms; Postoperative complications; Malnutrition; Nutritional assessment; Nutritional status; Perioperative care

1. Introduction

Nutritional health is a critical factor influencing surgical outcomes in individuals with gastrointestinal (GI) cancers, yet it is frequently overlooked in the perioperative period. Globally, GI cancers are among the most prevalent and lethal malignancies, contributing to more than 4.8 million new diagnoses and approximately 3.4 million deaths each year [1]. For patients with localized disease, surgical removal of the tumor remains the primary curative approach. Malnutrition in this population is not only a frequent consequence of the disease but also a modifiable predictor of postoperative outcomes [2]. Malnutrition rates among cancer patients range from 20% to 80% on the basis of the tumor site, disease stage, and assessment methods used [3].

The pathogenesis of cancer-associated malnutrition involves mechanical obstruction, systemic inflammation, altered metabolism, and reduced nutrient intake [4]. GI cancers, in particular, impair digestion, absorption, and nutrient utilization through mechanisms such as cachexia-induced hypermetabolism, nutrient sequestration by tumors, proteolysis, and GI dysfunction [5]. A large multicenter study revealed that 35–45% of patients who underwent major GI cancer surgery were severely malnourished, with the prevalence in certain subgroups reaching 80% [6]. In a global cohort of 5,709 patients, severe malnutrition was linked to a threefold increase in 30-day post-operative mortality, with rates of 8.1% compared with 2.8% [7].

The adverse impact of malnutrition on GI cancer patients extends beyond mortality, leading to an increased likelihood of wound infections, slower healing, prolonged hospital stays, higher healthcare costs, and reduced tolerance to adjuvant therapy [8,9]. Baseline malnutrition in older cancer patients has been significantly associated with an elevated risk of mortality [10]. Several nutritional valuation tools are commonly used in oncology to identify and address these risks, including the Patient-Generated Subjective Global Assessment (PG-SGA), Malnutrition Universal Screening Tool (MUST), and Global Leadership Initiative on Malnutrition (GLIM) criteria [11]. However, the optimal timing, methodology, and cutoff thresholds for defining malnutrition in the perioperative setting remain debated, and traditional laboratory indicators such as albumin (ALB), pre-ALB, and transferrin are limited by their sensitivity to inflammatory states [12]. These uncertainties are particularly relevant in resource-limited healthcare systems, where variability in assessment protocols and perioperative care may further influence patient outcomes [13,14].

Considering the high frequency and modifiable nature of malnourishment, there is a dire need for prospective data from diverse healthcare contexts to guide perioperative nutritional strategies. This prospective cohort study was designed to examine how patients' nutritional conditions before surgery influence postoperative outcomes following major GI cancer resection at a tertiary care center. We hypothesized that individuals with compromised nutritional status prior to surgery would be more prone to adverse postoperative events, require extended hospitalization, and face a greater risk of 30-day mortality than those who are well nourished.

2. Methods

2.1. Study design

This prospective cohort study was carried out between 1 June 2023 and 30 June 2024 at Lady Reading Hospital, MTI Peshawar.

2.2. Study settings

The research took place at Lady Reading Hospital, a public tertiary care facility located in Peshawar that provides specialized GI surgical services to Khyber Pakhtunkhwa Province and surrounding regions.

2.3. Study participants

Consecutive adult patients (≥18 years) scheduled for elective major GI cancer resection were considered for enrollment. The study recruited patients with a histologically confirmed gastrointestinal malignancy (gastric, colorectal, pancreatic, or hepatobiliary) who were listed for major resection with therapeutic curative intent, had an Eastern Cooperative Oncology Group (ECOG) performance status of 0–2, and were capable of providing written informed consent. However, patients who required emergency surgery, were scheduled for palliative procedures, had concurrent malignancies, presented with severe comorbidities precluding major surgery [American Society of Anesthesiologists (ASA) class IV–V], were unable to undergo nutritional assessment, or declined participation were excluded from the study.

2.4. Ethical considerations

The study was approved by the Institutional Review Board of Lady Reading Hospital, Peshawar (Approval No. 64/LRH/MTI). Prior to enrollment, written informed consent was obtained from all study participants.

2.5. Sample size

The sample size estimation followed the WHO recommendations for comparative study designs, with previously reported complication rates of 40% in malnourished individuals and 20% in those with adequate nutritional status [3,15]. With a type I error probability of 5%, a statistical power of 80%, and an anticipated 10% attrition rate, the final calculated sample size was 294 participants.

2.6. Data collection

Preoperative nutritional assessment was conducted within the first 48 hours of hospital admission using the PG-SGA as the primary evaluation tool. Patients were categorized on the basis of their PG-SGA scores as well nourished (scores up to 3), moderately malnourished (scores between 4 and 8), or severely malnourished (scores of 9 or above) [16]. Anthropometric measurements included height, weight, BMI [classified per the World Health Organization (WHO) criteria], and percentage weight loss over the preceding six months. The laboratory parameters included the serum ALB concentration, total protein concentration, hemoglobin level, and lymphocyte count, which were measured within 72 hours preoperatively.

Demographic data, tumor characteristics, comorbidities, and baseline nutritional parameters were recorded via standardized case report forms. Operative details—including procedure type, duration, estimated blood loss, and intraoperative complications—were documented. Postoperative outcomes were tracked for 30 days and included adverse events (classified according to the Clavien–Dindo system), total duration of hospitalization, unplanned readmissions within 30 days, and short-term postoperative mortality.

2.7. Statistical analysis

The data were analyzed with SPSS version 25. Descriptive statistics were used to summarize patient demographics, tumor characteristics, nutritional parameters, and postoperative outcomes. The means, medians, standard deviations, and interquartile ranges were calculated for age, BMI, weight loss percentage, serum ALB, hemoglobin, lymphocyte count, and hospital stay. Differences in these variables between nutritional status groups (well-nourished vs malnourished) were assessed via t tests or Mann–Whitney U tests, as appropriate. The sex distribution, ASA score (≥ 3 vs < 3), 30-day mortality, major complications, readmission, surgical site infection, anastomotic leakage, and respiratory complications were compared via the chi-square test or Fisher's exact test. Multivariate logistic regression analysis was performed, including all variables with $p < 0.10$ in univariate analysis and additional clinically meaningful covariates, to determine independent predictors of major surgical complications and 30-day mortality. Finally, odds ratios (ORs) with 95% confidence intervals (CIs) are reported, with significant predictors displayed in a forest plot. The level of significance was set at $p < 0.05$.

3. Results

The malnourished patients were, on average, older than the well-nourished patients were (66.2 ± 11.7 vs. 52.1 ± 11.2 years; $p < 0.001$), had lower BMI values (21.3 ± 3.8 vs. 24.7 ± 4.2 kg/m^2; $p < 0.001$), and experienced greater preoperative weight loss (12.4 ± 6.8% vs. 3.2 ± 2.1%; $p < 0.001$) (Table 1). The laboratory findings demonstrated that the malnourished group had a poorer nutritional and physiological profile, with significantly lower hemoglobin levels, total lymphocyte counts, and serum albumin (ALB) concentrations ($p < 0.001$). Moreover, a greater proportion of malnourished patients had an ASA score of 3 or more, indicating greater operative risk ($p < 0.001$).

Table 1. Baseline characteristics by nutritional status among the study participants.

Variables	Well-nourished (n = 166)	Malnourished (n = 128)	*p* Value
	Mean ± SD	Mean ± SD	
Age (in years)	52.1 ± 11.2	66.2 ± 11.7	< 0.001 ***
Male, n (%)	89 (53.6)	73 (57.0)	0.572
BMI (kg/m^2)	24.7 ± 4.2	21.3 ± 3.8	< 0.001 ***
Weight loss in last 6 months (%)	3.2 ± 2.1	12.4 ± 6.8	< 0.001 ***
Serum ALB (g/dL)	3.8 ± 0.4	2.8 ± 0.6	< 0.001 ***
Hemoglobin (g/dL)	12.1 ± 1.6	10.2 ± 1.8	< 0.001 ***
Lymphocyte count (cells/µL)	1,867 ± 523	1,248 ± 456	< 0.001 ***
ASA physical status ≥ 3, n (%)	34 (20.5)	52 (40.6)	< 0.001 ***

* Data were analyzed via t tests and chi-square tests. ** Nutritional status defined by the PG-SGA: well nourished (0–3) and malnourished (≥ 4). *** Statistically significant at $p < 0.05$.

Table 2 depicts the primary surgical outcomes stratified by nutritional status. Compared with well-nourished patients, those who were undernourished had a significantly increased risk of death during the first 30 postoperative days (12.5% vs 4.2%, $p = 0.008$), along with more frequent major complications (35.9% vs 18.1%, $p < 0.001$). Patients with malnutrition had a median hospital stay of 14 days, whereas those with adequate nutrition had a median hospital stay of only 9 days, which was highly significant ($p < 0.001$). Readmission occurred in 17.2% of the malnourished patients compared with 8.4% of the well-nourished patients ($p = 0.028$). Surgical site infection was observed in 18.4% and 8.4% of the patients, respectively ($p = 0.012$). Anastomotic leakage occurred in 8.6% versus 3.0% ($p = 0.044$), and respiratory complications occurred in 15.6% versus 6.6% ($p = 0.015$), all of which were significantly greater among malnourished patients.

Table 2. Primary surgical outcomes by nutritional status.

Outcomes	Well-nourished (n = 166)	Malnourished (n = 128)	*p* Value
	Frequency (%)	Frequency (%)	
30-day mortality	7 (4.2)	16 (12.5)	0.008 ***
Major complications	30 (18.1)	46 (35.9)	< 0.001 ***
Hospital stay (days), median (IQR)	9 (7-13)	14 (10-21)	< 0.001 ***

Outcomes	Well-nourished (n = 166)	Malnourished (n = 128)	*p* Value
	Frequency (%)	Frequency (%)	
Readmission	14 (8.4)	22 (17.2)	0.028 ***
Surgical site infection	14 (8.4)	23 (18.4)	0.012 ***
Anastomotic leakage	5 (3.0)	11 (8.6)	0.044 ***
Respiratory complications	11 (6.6)	20 (15.6)	0.015 ***

* Data were analyzed via the chi-square test, Fisher's exact test, and the Mann–Whitney U test. ** The Clavien–Dindo criteria were used to define major complications as grade ≥ 3. *** Statistically significant at $p < 0.05$.

Figure 1 delineates the independent predictors of major surgical complications and 30-day mortality after adjusting for confounding variables in a multivariate logistic regression model. Severe malnutrition was strongly associated with major complications, with an OR of 2.84 (95% CI 1.52–5.31, $p = 0.001$), indicating a nearly threefold increase in risk. Advanced age above 70 years was another significant predictor, with an OR of 2.12 (95% CI 1.18–3.81, $p = 0.012$), suggesting that elderly patients were approximately twice as likely to develop complications. An ASA score of ≥ 3 was also linked to increased risk, with an OR of 1.89 (95% CI 1.09–3.28, $p = 0.024$), whereas an operative duration longer than 240 minutes increased the risk by approximately two-thirds (OR 1.67, 95% CI 1.02–2.73, $p = 0.041$). For 30-day mortality, a serum ALB concentration below 3.2 g/dL emerged as the only independent predictor, conferring more than a threefold higher likelihood of death (OR 3.45, 95% CI 1.34–8.87, $p = 0.010$).

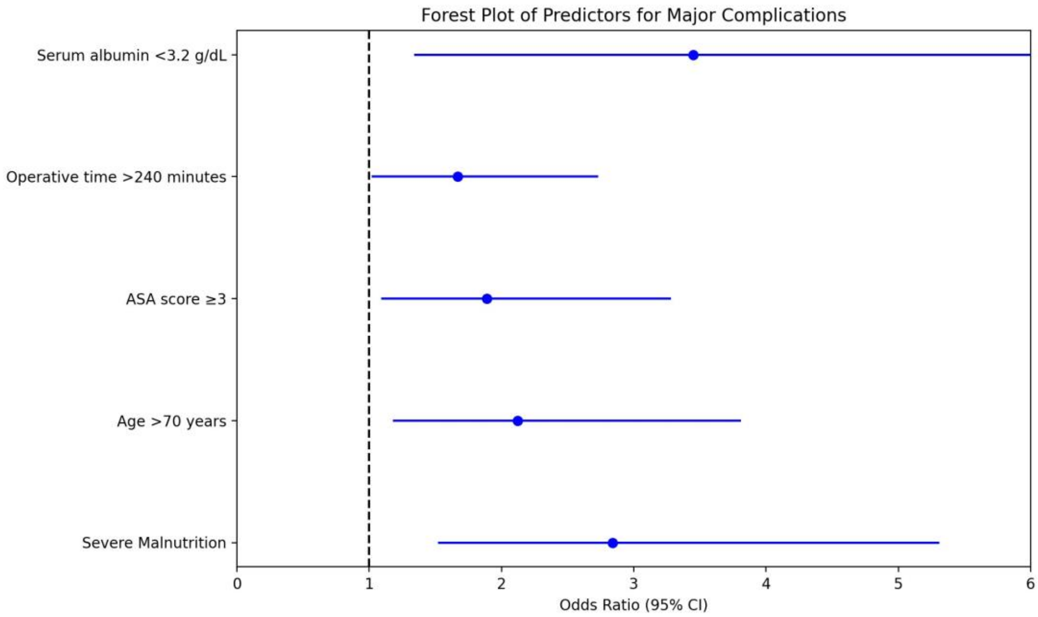

Figure 1. Forest plot of independent predictors of major surgical complications and 30-day mortality identified by multivariate logistic regression.

4. Discussion

This prospective cohort study revealed that preoperative nutritional status was strongly and clinically significantly linked with postoperative outcomes in patients who underwent major GI cancer surgery. Nearly half of our cohort was nutritionally compromised preoperatively, and malnourished patients experienced markedly higher 30-day mortality rates, major complication rates, and prolonged hospital stays than their well-nourished counterparts did. These findings reinforce the key role of nutritional status, a potentially modifiable determinant of perioperative outcomes in GI cancer surgical procedures, particularly in resource-limited settings.

The malnutrition prevalence recorded by our study is in line with global estimates. Recent multicenter data reported malnutrition or nutritional risk in 35–50% of GI cancer surgery patients, depending on the assessment tool used [17,18]. In a large prospective study, more than one-third of patients (39%) were predisposed to undernourishment at admission (MUST score ≥1), with 17.9% at moderate risk and 21.1% at severe risk [17]. This alignment across diverse healthcare systems suggests that malnutrition is a universal challenge in GI cancer care, transcending geographical and socioeconomic boundaries.

The mortality outcomes in our study further highlight the prognostic impact of malnutrition. The thirty-day mortality rate was 12.5% in undernourished patients in comparison with 4.2% in optimally nourished patients ($p = 0.008$), closely paralleling the landmark international study by Biccard et al., which reported 11.36% versus 2.27% in severely malnourished and well-nourished patients, respectively [19]. Our slightly higher mortality rates may reflect differences in healthcare infrastructure, perioperative protocols, and patient complexity. In the multivariate analysis, severe malnutrition independently predicted major complications, highlighting the importance of preoperative optimization.

The complication rates followed a similar pattern. In malnourished patients, surgical site infections, anastomotic leakage, and respiratory complications occurred at a notably higher incidence, representing major postoperative complications. These findings mirror those of Abrha et al., who reported 3–4 times higher complication and mortality rates in malnourished surgical patients, along with extended hospital stays and approximately 50% greater costs [15]. The increased median length of stay in our malnourished group likely reflects both the greater complication burden and delayed recovery [20].

Nutritional biomarkers also play a prognostic role. A serum ALB concentration <3.2 g/dL was a self-regulating predictor of 30-day mortality, which is consistent with ACS-NSQIP data from over 42,000 colorectal cancer patients [21]. Although the serum ALB concentration is influenced by the inflammatory state and is not a pure nutritional marker, its predictive value in the perioperative setting remains clinically relevant. Our findings support its use as part of a comprehensive valuation strategy rather than as a stand-alone test.

Recent frameworks, such as the GLIM criteria, advocate the integration of phenotypical and etiological criteria to advance diagnostic precision [22]. GLIM-defined malnutrition has been shown to outperform traditional tools in anticipating postoperative medical complications in colorectal cancer patients [23]. In our study, nutritional assessment was conducted via the validated PG-SGA, which remains widely used in oncology. However, integration with the GLIM criteria and body composition analysis may further refine perioperative risk stratification.

Operative factors also differed between groups, with malnourished patients experiencing longer operative times and greater estimated blood loss. Malnutrition is known to impair tissue healing, collagen synthesis, and immune function, all of which can increase surgical complexity and susceptibility to complications [24]. These physiological disadvantages may play a potential role in the prolonged recovery and increased complication rates observed.

Beyond surgical complexity, malnutrition biologically predisposes patients to adverse outcomes by impairing immune defenses, slowing collagen synthesis, and delaying angiogenesis. These mechanisms collectively increase susceptibility to infection, wound breakdown, and prolonged recovery, helping to explain the complications observed in our cohort.

The adverse outcomes associated with malnutrition may be amenable to targeted intervention. Li et al. reported that timely postoperative enteral nourishment in gastric cancer patients shortened the hospital stay by approximately two days (7.73 vs 9.77 days, $p = 0.002$), although it did not significantly reduce complication rates [25]. Similarly, the NOURISH study highlighted the importance of early intervention and standardized nutritional assessment protocols in upper GI cancer patients [26]. Given our findings, the implementation of structured perioperative nutrition programs could represent a cost-effective strategy for improving outcomes, especially in resource-limited environments. Taken together, these results highlight the clinical importance of early perioperative nutritional care. Routine screening, timely initiation of enteral/oral nutrition, and selective immunonutrition within ERAS protocols may reduce morbidity and enhance recovery in high-risk patients [27].

Sarcopenia, which is characterized by the loss of skeletal muscle mass and function, has been identified as an important component of cancer-associated malnutrition. Several studies have demonstrated that sarcopenia functions as an independent determinant of postoperative outcomes and long-term survival in individuals with GI cancer, even after adjusting for conventional nutritional indicators [28]. Future studies in our setting should consider incorporating CT-based muscle mass assessment to capture this dimension of nutritional status. These observations are consistent with international studies, where sarcopenia and altered body composition independently predicted complications and survival in patients who underwent GI cancer surgery. Similarly, in multicenter cohorts from Europe and Asia, the use of CT-based skeletal muscle indices and the EWGSOP2/AWGS criteria revealed that reduced muscle mass or strength was strongly associated with morbidity and mortality. This finding reinforces the global validity of our findings.

In high-income countries, malnourished surgical patients often incur 30–100% higher healthcare costs than well-nourished patients do, largely due to increased complications and longer hospital stays. [29]. In low-resource settings, cost-effective screening and targeted interventions could yield significant financial and clinical benefits, supporting both patient care and system sustainability.

Our study has various limitations. The relatively small sample size and single-center study design may limit generalizability, predominantly to centers with different case mixtures or perioperative protocols. While we used validated tools for nutritional assessment, the absence of body composition analysis limits the completeness of nutritional profiling. We did not evaluate the impact of specific nutritional interventions, which could provide insight into modifiable outcome determinants. Moreover, the lack of an interventional arm prevents conclusions about whether targeted nutritional therapy could affect outcomes. The observational nature of the study further limits the ability to infer causality. Finally, our 30-day follow-up precludes the assessment of long-term oncologic outcomes and survival.

Future research should prioritize randomized controlled trials evaluating perioperative nutritious interventions in GI cancer patients. The development and validation of simplified, cost-effective screening tools tailored to resource-limited settings would improve the adoption of routine nutritional assessment. Integration of body composition analysis into future studies may increase the accuracy of nutritional risk stratification and its predictive value for clinical outcomes. Studies exploring the relationships between nutritional status and long-term oncologic results are also needed. Finally, economic evaluations of nutritional programs could provide an evidence base for policy and resource allocation decisions.

5. Conclusions

This study demonstrated that preoperative malnutrition is a strong determinant of adverse surgical outcomes in GI cancer patients undergoing major resection. Nearly half of the cohort presented with nutritional compromise, and malnourished patients had significantly higher mortality rates, complication rates, and longer hospital stays. Severe malnutrition is recognized as an independent indicator of poor outcomes, highlighting the need for routine preoperative nutritional and dietary screening and targeted perioperative support. These findings advocate incorporating comprehensive nutritional assessment into standard care pathways for GI cancer surgery to improve patient outcomes and optimize healthcare resource use.

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Ethics statement: The study was approved by the Institutional Review Board of Lady Reading Hospital, Peshawar (Approval No. 64/LRH/MTI).

Consent to participate: Not applicable.

Data availability: The data supporting this study's findings are available from the corresponding author, Ihtisham Ul Haq, upon reasonable request.

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