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Clinical Significance of Preoperative Serum Albumin Levels in Predicting Survival after Surgery in Patients Undergoing Colorectal Cancer Resection

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A B S T R A C T

Introduction: Colorectal cancer surgery outcomes are influenced not only by tumor characteristics but also by the patient's nutritional and inflammatory status. Serum albumin, a widely available biomarker, reflects both physiological reserve and systemic inflammation and has been linked to postoperative prognosis. This study aimed to evaluate the clinical significance of preoperative serum albumin levels in predicting survival after colorectal cancer surgery.

Material and methods: This observational analytical study was conducted in 2025 at hospitals affiliated with Tabriz University of Medical Sciences. A total of 85 colorectal cancer patients undergoing surgical resection were enrolled using convenience sampling. Demographic characteristics, clinical variables, tumor features, preoperative serum albumin levels, and postoperative survival outcomes were collected and analyzed to evaluate the prognostic value of albumin.

Results: Among 85 patients undergoing colorectal cancer surgery, hypoalbuminemia (<3.5 g/dL) was present in 36.47%. Lower albumin was associated with higher BMI (P=0.041) and advanced tumor stage (P=0.032). Patients with low albumin had shorter survival (24.83 ± 9.71 vs 33.47 ± 11.26 months; P=0.006) and higher mortality (35.48% vs 16.67%; P=0.047). Hypoalbuminemia independently predicted mortality (HR=2.47, 95% CI:1.29-4.73; P=0.006) with good ROC performance (AUC=0.80).

Conclusion: Preoperative hypoalbuminemia was significantly associated with poorer survival after colorectal cancer surgery and remained an independent predictor of mortality. These findings highlight the importance of assessing nutritional and inflammatory status before surgery. Serum albumin, as a simple and accessible biomarker, may assist clinicians in identifying high-risk patients and improving preoperative risk stratification.

Introduction

Colorectal cancer remains one of the most common malignancies worldwide and continues to represent a major cause of cancer-related morbidity and mortality. Despite significant advances in screening, surgical techniques, perioperative care, and adjuvant therapies, long-term survival outcomes still vary considerably among patients undergoing colorectal cancer resection. Tumor stage and pathological characteristics traditionally considered the most important determinants of prognosis; however, increasing evidence suggests that host-related biological factors also play a critical role in influencing postoperative outcomes and long-term survival.

In recent years, attention has increasingly focused on identifying easily measurable biomarkers that reflect the patient's physiological reserve, inflammatory status, and nutritional condition prior to surgery. Such markers may help clinicians refine

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risk stratification, optimize perioperative management, and predict long-term survival beyond conventional tumor-related parameters (1,2).

Surgical resection remains the cornerstone of curative treatment for patients with non-metastatic colorectal cancer and frequently combined with systemic chemotherapy depending on tumor stage and risk profile. However, major abdominal surgery imposes substantial metabolic and inflammatory stress on the body. Patients presenting with impaired nutritional status or systemic inflammation known to experience higher rates of postoperative complications, prolonged hospitalization, and poorer oncologic outcomes. Consequently, the evaluation of preoperative physiological status has become an important component of modern oncologic care. Nutritional and inflammatory biomarkers are increasingly incorporated into clinical assessment because they offer insight into the biological environment in which tumor progression and postoperative recovery occur (3, 4).

Among the various biomarkers proposed for prognostic assessment, serum albumin has attracted considerable interest because of its strong relationship with nutritional status, systemic inflammation, and overall physiological reserve. Albumin is the most abundant circulating plasma protein and synthesized primarily by hepatocytes. It plays multiple physiological roles, including maintenance of oncotic pressure, transport of endogenous and exogenous substances, and modulation of antioxidant and anti-inflammatory mechanisms. In clinical practice, serum albumin concentration is widely used as an indicator of nutritional status, has incorporated into several established clinical scoring systems such as the prognostic nutritional index, other inflammation-based prognostic scores. Low albumin levels frequently reflect a combination of malnutrition, chronic inflammation, and metabolic stress, conditions that are common in patients with advanced malignancy (5,6).

Malnutrition is particularly prevalent among patients with gastrointestinal cancers, including colorectal cancer. Tumor-related metabolic alterations, decreased oral intake, intestinal obstruction, and systemic inflammatory responses can all contribute to progressive nutritional deterioration. Malnutrition has been associated with impaired immune function, delayed wound healing, and reduced tolerance to surgical and oncologic treatments. In colorectal cancer surgery, preoperative malnutrition has linked to increased postoperative morbidity, infectious complications, and prolonged recovery. Because serum albumin reflects both nutritional depletion and systemic inflammatory activity, it has been proposed as a simple and accessible biomarker that may capture several biological processes influencing surgical outcomes simultaneously (7, 8).

In addition to its role as a nutritional marker, serum albumin closely connected with systemic inflammatory pathways that influence cancer progression and patient survival. Chronic inflammation has long recognized as a key contributor to tumor development, angiogenesis, and metastatic spread. Pro-inflammatory cytokines such as interleukin-6 and tumor necrosis factor-α can suppress hepatic albumin synthesis while simultaneously promoting tumor growth and altering immune responses. Consequently, hypoalbuminemia may serve as an indirect indicator of an enhanced inflammatory state associated with more aggressive tumor biology. This dual relationship with both nutritional status and inflammation makes albumin a particularly valuable candidate biomarker in oncologic prognostication (9, 10).

Several clinical studies have suggested that preoperative hypoalbuminemia may be associated with worse postoperative outcomes and reduced overall survival in various malignancies, including gastric, pancreatic, and lung cancers. In colorectal cancer specifically, investigators have reported correlations between low serum albumin levels and increased postoperative complications, poorer tolerance to adjuvant therapy, and decreased long-term survival. However, the strength and consistency of these associations remain subjects of ongoing investigation. Differences in patient populations, tumor stages, surgical approaches, and cutoff values used to define hypoalbuminemia have produced variable results across studies. Consequently, further evaluation in diverse clinical settings remains important to clarify the prognostic value of this biomarker (11, 12).

Beyond predicting postoperative complications, serum albumin may also influence long-term oncologic outcomes through several biological mechanisms. Adequate nutritional status is essential for maintaining effective cellular immunity, which plays a critical role in tumor surveillance and response to treatment. Patients with reduced albumin levels often demonstrate impaired T-cell function, diminished cytokine regulation, reduced resistance to infection, tumor progression. Furthermore, systemic inflammation associated with hypoalbuminemia can promote tumor cell proliferation, invasion, and angiogenesis through multiple molecular pathways. These biological processes may partly explain why patients with low preoperative albumin frequently experience poorer survival outcomes after colorectal cancer surgery (13, 14).

The clinical appeal of serum albumin as a prognostic marker lies not only in its biological relevance but also in its practicality. Albumin measurement is inexpensive, widely available, and routinely performed as part of standard preoperative laboratory evaluation. Unlike complex molecular

biomarkers, it does not require specialized equipment or advanced laboratory techniques. This accessibility allows clinicians to incorporate albumin levels easily into routine preoperative risk assessment. In resource-limited settings, simple laboratory indicators such as serum albumin may be particularly valuable for identifying high-risk patients and guiding perioperative decision-making (15,16).

Recent interest in perioperative optimization strategies has further increased the importance of identifying reliable nutritional and inflammatory markers. Enhanced recovery after surgery (ERAS) protocols emphasize the correction of modifiable risk factors prior to major surgery, including nutritional deficiencies and metabolic disturbances. Identifying patients with hypoalbuminemia before colorectal cancer surgery may provide an opportunity for targeted nutritional support, prehabilitation programs, and closer postoperative monitoring. Such interventions have the potential to improve surgical outcomes and may also influence long-term survival by strengthening physiological resilience during cancer treatment (17,18).

Although numerous prognostic models have proposed for colorectal cancer, many rely primarily on tumor-specific characteristics such as stage, lymph node involvement, and histopathological features. While these parameters remain essential, they do not fully capture the complex interplay between tumor biology and host physiology. Integrating host-related biomarkers, including indicators of nutrition and inflammation, may enhance the predictive accuracy of existing models. Serum albumin, because of its multifaceted biological significance, represents a promising candidate for inclusion in such integrated prognostic frameworks (19,20).

Furthermore, identifying reliable prognostic indicators has important implications for personalized oncologic care. Patients identified as high risk based on preoperative biomarkers may benefit from more intensive surveillance strategies, earlier initiation of adjuvant therapy, or closer postoperative follow-up. Conversely, patients with favorable biological profiles may avoid unnecessary interventions and treatment-related toxicity. In this context, simple laboratory parameters such as serum albumin may contribute to more individualized treatment planning and improve the overall quality of cancer care (21,22).

Despite the growing body of literature exploring the prognostic role of albumin, uncertainties remain regarding its independent predictive value and optimal clinical application in colorectal cancer surgery. Variations in study design, sample size, and patient characteristics have led to inconsistent conclusions in some reports. Additionally, the relative contribution of albumin compared with other inflammatory and nutritional markers has not fully established. Therefore, continued research is needed to better understand how preoperative albumin levels relate to survival outcomes and how this biomarker can be integrated into clinical decision-making processes (23,24).

Given these considerations, evaluating the clinical significance of preoperative serum albumin levels in patients undergoing colorectal cancer surgery may provide valuable insights into patient prognosis and perioperative risk stratification. By examining the relationship between albumin concentration and postoperative survival outcomes, clinicians may gain a clearer understanding of how nutritional and inflammatory status influence long-term cancer prognosis. Such knowledge could ultimately contribute to improved patient selection, optimized perioperative management, and enhanced survivorship outcomes for individuals undergoing surgical treatment for colorectal cancer.

Material and methods

Study Design

This observational analytical study conducted in 2025 in hospitals affiliated with Tabriz University of Medical Sciences, Iran. The study aimed to evaluate the prognostic significance of preoperative serum albumin levels in predicting postoperative survival among patients undergoing surgical treatment for colorectal cancer. Eligible patients enrolled at the time of hospital admission for elective colorectal cancer surgery and subsequently followed to assess survival outcomes.

Sampling and Sample Size Determination

The required sample size calculated using the standard formula for estimating a population proportion (single population proportion formula). The assumptions included an expected prevalence of low preoperative albumin among colorectal cancer patients of approximately 40%, a confidence level of 95%, and a margin of error of 10%. Based on these assumptions, the estimated sample size was 85 patients. Participants were recruited using a convenience sampling method from patients admitted for colorectal cancer surgery in the participating hospitals during the study period.

Eligibility Criteria

Inclusion criteria consisted of adult patients aged 18 years or older with histologically confirmed colorectal cancer who were candidates for curative surgical resection and had available preoperative laboratory data including serum albumin measurement. Patients were required to undergo elective colorectal cancer surgery and provide consent for participation and follow-up. Exclusion criteria included patients with metastatic disease deemed unrespectable, those undergoing palliative procedures only, individuals with severe hepatic failure or nephrotic syndrome that could

significantly alter albumin levels, patients with active systemic infection or inflammatory disease at the time of surgery, individuals with incomplete clinical records, and patients lost to follow-up after surgery.

Study Procedure and Variables

Upon enrollment, baseline demographic and clinical data collected, including age, sex, body mass index (BMI), smoking status, comorbidities such as diabetes mellitus and hypertension, tumor location, tumor stage, and preoperative laboratory parameters. Surgical procedures performed according to standard oncologic principles by experienced colorectal surgeons. Depending on tumor location and clinical indications, patients underwent appropriate resections such as right hemicolectomy, left hemicolectomy, sigmoid colectomy, or low anterior resection with adequate lymph node dissection. Preoperative serum albumin levels measured from venous blood samples obtained within 48 hours prior to surgery using an automated biochemical analyzer based on the bromocresol green colorimetric method. Survival status was determined through review of hospital records and follow-up contact with patients or their families. Overall survival defined as the time interval between the date of surgery and death from any cause or the last documented follow-up.

Statistical Analysis

Statistical analyses performed using standard statistical software. Continuous variables expressed as mean ± standard deviation or median with interquartile range depending on data distribution, while categorical variables presented as frequencies and percentages. The normality of continuous variables assessed using the Kolmogorov-Smirnov test. Comparisons between groups performed using the independent samples t-test or Mann-Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables. Survival analysis conducted using the Kaplan–Meier method, and differences in survival between groups evaluated using the log-rank test. Cox proportional hazards regression analysis performed to identify independent predictors of survival. Variables with P values less than 0.10 in univariate analysis entered into multivariable regression models. A P value less than 0.05 considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the Ethics Committee of Tabriz University of Medical Sciences (Ethics Code: IR.TBZMED.FMD.REC.1404.490). All procedures conducted in accordance with ethical standards for medical research involving human participants. Patient confidentiality maintained throughout the study, and all collected data analyzed anonymously.

Results

85 patients with histologically confirmed colorectal cancer who underwent curative surgical resection were included in the analysis (table 1). The cohort had a mean age of 58.37 ± 11.46 years and consisted predominantly of male patients. Colon tumors were more frequent than rectal tumors, and most cases diagnosed at stage II or III. Comorbid conditions such as hypertension and diabetes were present in a subset of patients. The overall mean preoperative serum albumin level was 3.74 ± 0.58 g/dL.

Table 1. Baseline Clinical and Demographic Characteristics of Patients Undergoing Colorectal Cancer Surgery

Variable	Value
Age (years), Mean ± SD	58.37 ± 11.46
Sex	-
Male	49 (57.65)
Female	36 (42.35)
BMI (kg/m²), Mean ± SD	27.18 ± 4.12
Current smoker, n (%)	18 (21.18)
Diabetes mellitus, n (%)	19 (22.35)
Hypertension, n (%)	24 (28.24)
Tumor location	-
Colon	53 (62.35)
Rectum	32 (37.65)
Tumor stage	-
Stage I	14 (16.47)
Stage II	31 (36.47)
Stage III	29 (34.12)
Stage IV	11 (12.94)
Type of surgery	-
Right hemicolectomy	21 (24.71)
Left hemicolectomy	16 (18.82)

Sigmoid colectomy	20 (23.53)
Low anterior resection	19 (22.35)
Abdominoperineal resection	9 (10.59)
Preoperative albumin (g/dL), Mean ± SD	3.74 ± 0.58

Abbreviations: BMI, body mass index; SD, standard deviation.

Patients stratified according to their preoperative serum albumin level into two groups: low albumin (<3.5 g/dL) and normal albumin (≥3.5 g/dL). Overall, 31 patients (36.47%) had hypoalbuminemia, while 54 patients (63.53%) had normal albumin levels. Individuals with lower albumin tended to have a higher mean BMI and a greater proportion of advanced tumor stage, whereas most other baseline variables were relatively comparable between groups. These comparisons performed to determine whether clinical characteristics differed according to preoperative nutritional status (table 2).

Table 2. Comparison of Clinical and Tumor Characteristics According to Preoperative Serum Albumin Level

Variable	Low Albumin (<3.5 g/dL) n=31	Normal Albumin (≥3.5 g/dL) n=54	P value
Age (years), Mean ± SD	60.84 ± 10.92	56.91 ± 11.73	0.118
Male sex, n (%)	17 (54.84)	32 (59.26)	0.693
BMI (kg/m²), Mean ± SD	28.46 ± 4.37	26.49 ± 3.95	0.041
Tumor location	-	-	0.517
Colon, n (%)	18 (58.06)	35 (64.81)	-
Rectum, n (%)	13 (41.94)	19 (35.19)	-
Tumor stage	-	-	0.032
Stage I, n (%)	3 (9.68)	11 (20.37)	-
Stage II, n (%)	9 (29.03)	22 (40.74)	-
Stage III, n (%)	13 (41.94)	16 (29.63)	-
Stage IV, n (%)	6 (19.35)	5 (9.26)	-
Type of surgery	-	-	0.441
Right hemicolectomy	7 (22.58)	14 (25.93)	-
Left hemicolectomy	6 (19.35)	10 (18.52)	-
Sigmoid colectomy	7 (22.58)	13 (24.07)	-
Low anterior resection	8 (25.81)	11 (20.37)	-
Abdominoperineal resection	3 (9.68)	6 (11.11)	-
Diabetes mellitus, n (%)	9 (29.03)	10 (18.52)	0.261
Hypertension, n (%)	11 (35.48)	13 (24.07)	0.268

Abbreviations: BMI, body mass index; SD, standard deviation.

Survival analysis performed to evaluate the prognostic impact of preoperative serum albumin levels. During a median follow-up period of 28.64 months, mortality occurred more frequently among patients with hypoalbuminemia. Individuals with low albumin demonstrated shorter overall survival and lower 1-year and 3-year survival rates compared with those with normal albumin levels. The difference in survival distributions between the two groups was statistically significant based on the log-rank test (table 3).

Table 3. Survival Outcomes According to Preoperative Serum Albumin Level (n = 85)

Survival Outcome	Low Albumin (<3.5 g/dL) n=31	Normal Albumin (≥3.5 g/dL) n=54	P value (log-rank)
Overall survival (months), Mean ± SD	24.83 ± 9.71	33.47 ± 11.26	0.006
1-year survival rate, n (%)	23 (74.19)	49 (90.74)	0.038
3-year survival rate, n (%)	15 (48.39)	39 (72.22)	0.021
Mortality during follow-up, n (%)	11 (35.48)	9 (16.67)	0.047

Abbreviations: SD, standard deviation.

To identify independent predictors of postoperative survival, Cox proportional hazards regression analysis performed. Initially, univariate models constructed for demographic and clinical variables potentially associated with mortality. Variables demonstrating potential prognostic relevance

subsequently entered into a multivariate model to adjust for confounding effects. The analysis demonstrated that advanced tumor stage and lower preoperative albumin levels were significantly associated with poorer survival outcomes. Importantly, hypoalbuminemia remained an independent predictor of mortality after adjustment for other clinical variables (table 4).

Table 4. Cox Proportional Hazards Regression Analysis for Predictors of Postoperative Survival in Patients Undergoing Colorectal Cancer Surgery

Variable	Hazard Ratio (HR)	95% CI	P value
Univariate Analysis	-	-	-
Age (per year increase)	1.03	0.99 – 1.07	0.112
BMI (kg/m²)	1.05	0.97 – 1.14	0.198
Tumor stage (III–IV vs I–II)	2.41	1.32 – 4.39	0.004
Tumor location (rectum vs colon)	1.27	0.69 – 2.36	0.421
Diabetes mellitus	1.46	0.79 – 2.71	0.224
Smoking	1.58	0.86 – 2.90	0.141
Low albumin (<3.5 g/dL)	2.93	1.56 – 5.51	0.001
Multivariate Analysis	-	-	-
Age	1.02	0.98 – 1.06	0.284
BMI	1.04	0.95 – 1.13	0.361
Tumor stage (III–IV vs I–II)	2.12	1.14 – 3.94	0.018
Smoking	1.39	0.72 – 2.70	0.322
Low albumin (<3.5 g/dL)	2.47	1.29 – 4.73	0.006

Abbreviations: HR, hazard ratio; CI, confidence interval; BMI, body mass index.

Preoperative serum albumin showed good discriminatory performance for predicting mortality after colorectal cancer surgery. The ROC analysis yielded an AUC of 0.80, indicating acceptable to good accuracy. The optimal cut-off value was 3.50 g/dL, with moderate sensitivity and high specificity, suggesting that lower albumin levels may be clinically useful for identifying patients at increased risk of postoperative death (figure 1).

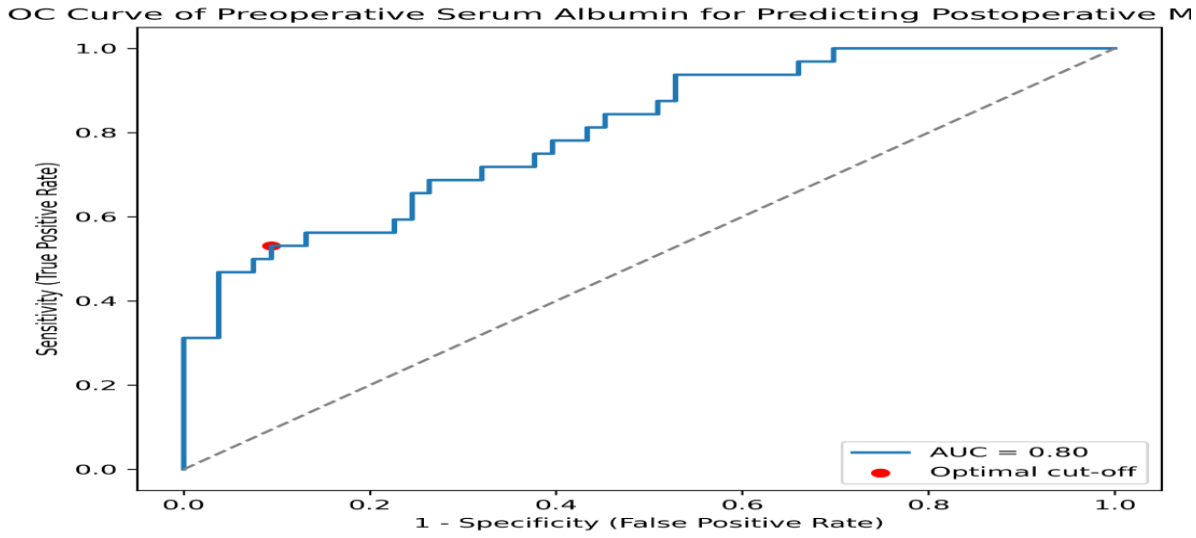

Figure 1. Receiver Operating Characteristic (ROC) Curve for Preoperative Serum Albumin in Predicting Mortality after Colorectal Cancer Surgery

Discussion

The present study evaluated the prognostic significance of preoperative serum albumin in patients undergoing surgery for colorectal cancer. The findings demonstrate that patients with lower preoperative albumin levels exhibited less favorable clinic pathological profiles and poorer survival outcomes. Hypoalbuminemia was associated with more advanced tumor stage and linked to shorter survival and higher mortality during follow-up. Importantly, multivariate Cox regression analysis confirmed that low serum albumin remained an independent predictor of postoperative mortality even after adjusting for other clinical variables. Furthermore, ROC analysis indicated that preoperative albumin had acceptable discriminative

ability for predicting mortality, suggesting its potential value as a practical prognostic biomarker in surgical oncology.

These findings are consistent with the growing body of evidence indicating that preoperative nutritional and inflammatory status plays a critical role in determining outcomes after colorectal cancer surgery. Albumin has long recognized as a surrogate marker of nutritional reserve and systemic inflammation. Patients with reduced serum albumin levels often exhibit impaired protein synthesis, chronic inflammation, and metabolic stress, all of which may compromise physiological resilience during the perioperative period. In the context of colorectal cancer, malnutrition is relatively common due to cancer-related anorexia, intestinal dysfunction, and increased metabolic demands, which collectively contribute to decreased albumin levels and worse postoperative outcomes (25).

One plausible explanation for the association between hypoalbuminemia and poor survival relates to the biological role of albumin in maintaining physiological homeostasis. Albumin contributes to oncotic pressure regulation, transport of hormones and drugs, antioxidant activity, and modulation of inflammatory responses. When albumin levels reduced, these protective physiological mechanisms may become impaired. Reduced oncotic pressure can lead to tissue edema and impaired microcirculation, potentially affecting tissue oxygenation and wound healing. In addition, albumin possesses antioxidant properties that help neutralize reactive oxygen species; therefore, low albumin levels may increase oxidative stress, which has implicated in tumor progression and impaired recovery after surgery (26).

Another important explanation involves the close relationship between albumin and systemic inflammatory activity. Hypoalbuminemia is often not solely a consequence of inadequate nutrition but also reflects chronic inflammation mediated by cytokines such as interleukin-6 and tumor necrosis factor-α. These inflammatory mediators suppress hepatic albumin synthesis while simultaneously promoting tumor proliferation, angiogenesis, and immune dysregulation. Consequently, low albumin may represent a composite indicator of both nutritional depletion and cancer-associated inflammatory burden. This dual role likely explains why albumin has repeatedly identified as a strong predictor of survival in multiple gastrointestinal malignancies (27).

The current results also demonstrated that patients with lower albumin levels tended to present with more advanced tumor stages. Several mechanisms may account for this association. Advanced tumors often induce systemic metabolic alterations characterized by cachexia, muscle wasting, and increased catabolic activity, all of which can contribute to decreased albumin synthesis. Furthermore, advanced disease may impair gastrointestinal absorption and appetite, leading to progressive nutritional deterioration. Thus, hypoalbuminemia may reflect the systemic metabolic impact of more aggressive tumor biology rather than simply a preexisting nutritional deficiency (28).

Beyond its biological implications, preoperative albumin may influence postoperative recovery and complication risk, which indirectly affects long-term survival. Patients with poor nutritional status often experience impaired wound healing, higher susceptibility to infection, and reduced tolerance to surgical stress. These factors can delay recovery, prolong hospitalization, and limit the ability to receive timely adjuvant therapy such as chemotherapy. In colorectal cancer management, the timely initiation of adjuvant treatment is essential for improving survival outcomes; therefore, patients with compromised nutritional reserves may ultimately experience inferior oncologic results (29).

The multivariate analysis in this study demonstrated that hypoalbuminemia remained an independent predictor of mortality even after adjusting for tumor stage and other clinical variables. This observation highlights the potential clinical importance of albumin as a readily available and inexpensive biomarker that captures aspects of patient physiology not fully reflected by tumor characteristics alone. Traditional prognostic models in colorectal cancer rely heavily on pathological staging; however, patient-related factors such as systemic inflammation, immune competence, and nutritional reserve increasingly recognized as critical determinants of survival. The inclusion of albumin in risk stratification models may therefore improve prognostic accuracy and guide individualized perioperative management strategies (30).

The ROC analysis further supported the prognostic utility of serum albumin by demonstrating acceptable discriminatory ability for predicting mortality. Although albumin alone cannot fully predict long-term outcomes, its relatively high specificity suggests that patients with markedly reduced albumin levels represent a subgroup with particularly elevated risk. Identifying such patients before surgery may allow clinicians to implement targeted interventions, including nutritional optimization, rehabilitation programs, and closer postoperative monitoring. Increasing attention has recently directed toward multimodal rehabilitation strategies that combine nutritional supplementation, physical conditioning, and metabolic optimization to improve surgical resilience in high-risk patients (31).

Another relevant consideration is the role of albumin within broader inflammatory and nutritional prognostic indices. Several composite biomarkers,

such as the prognostic nutritional index (PNI), the Glasgow prognostic score (GPS), and the controlling nutritional status (CONUT) score, incorporate albumin as a central component. These indices have demonstrated strong predictive value in colorectal cancer and other malignancies. The consistent inclusion of albumin within these models underscores its importance as a key indicator of the host-tumor interaction and systemic physiological reserve (32).

From a practical perspective, the clinical utility of serum albumin enhanced by its simplicity and universal availability. Unlike many molecular or genetic biomarkers that require specialized testing, albumin measurement routinely performed in preoperative assessments worldwide. Consequently, incorporating albumin into prognostic evaluation does not increase healthcare costs or require additional infrastructure. This accessibility makes albumin particularly valuable in resource-limited settings where advanced biomarker testing may not be feasible but where risk stratification remains essential for optimizing patient care (33).

Despite the strengths of the present study, several limitations acknowledged. First, the observational design limits the ability to establish causal relationships between albumin levels and survival outcomes. Second, albumin measurements obtained at a single preoperative time point and therefore may not fully capture dynamic changes in nutritional status over time. Third, other inflammatory biomarkers such as C-reactive protein or neutrophil-to-lymphocyte ratio not evaluated, which might have provided additional insight into the inflammatory mechanisms underlying hypoalbuminemia. Future prospective studies with larger sample sizes and comprehensive biomarker assessment may help clarify the complex interplay between nutrition, inflammation, and oncologic outcomes in colorectal cancer (34).

In summary, the findings of this study suggest that preoperative serum albumin is a clinically meaningful prognostic indicator in patients undergoing colorectal cancer surgery. Hypoalbuminemia was associated with more advanced disease and significantly worse survival, and it remained an independent predictor of mortality after adjustment for potential confounders. These results support the integration of serum albumin into preoperative risk assessment and highlight the importance of evaluating nutritional status as part of comprehensive oncologic care. Early identification and correction of nutritional deficiencies may represent an important strategy for improving surgical and long-term outcomes in patients with colorectal cancer (35).

Conclusion

This study demonstrates that preoperative serum albumin is a clinically meaningful prognostic indicator in patients undergoing colorectal cancer resection. Patients with hypoalbuminemia experienced significantly lower survival rates and higher mortality during follow-up. Multivariate Cox regression confirmed that low albumin independently predicted postoperative mortality, even after adjusting for other clinical variables including tumor stage. Additionally, ROC analysis showed that albumin had good discriminatory ability for identifying patients at increased risk of death. Given its low cost, widespread availability, and strong association with survival outcomes, serum albumin may serve as a valuable component of preoperative evaluation and risk stratification in colorectal cancer surgery.

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Conflicts of interest

The authors declare that they have no competing interests.

Disclosure Statement

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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