Research Article

Comparison Of Sarcopenia Prevalence In Patients With Colorectal Cancer Versus Benign Colorectal Diseases Undergoing Surgery

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Abstract

Objective: To compare the prevalence of sarcopenia among patients with colorectal cancer and benign colorectal diseases undergoing colorectal s urgery.
Methods: This was a comparative cross-sectional analytical study of 176 patients who underwent colorectal surgery, 88 of whom had colorectal cancer and 88 had benign colorectal diseases. Demographic, anthropometric, clinical, and nutritional data were gathered. SMA was measured at the third level of the lumbar vertebra by computed tomography (CT) before surgery, and skeletal muscle index (SMI) was also computed. The chi-square test was used to compare the prevalence of sarcopenia between groups of people. Logistic regression was used to assess factors associated with sarcopenia.
Results: Sarcopenia was significantly more prevalent among patients with colorectal cancer than those with benign colorectal diseases (p=0.003). The skeletal muscle index was significantly reduced in patients with CRC compared with the benign disease group (p=0.001). Older age, nutritional compromise, body mass index (BMI), weight loss, and colorectal cancer were related to sarcopenia. Multivariable analysis revealed that age ≥60 years, BMI <23 kg/m², weight loss, and colorectal cancer were all still independent of sarcopenia. There were statistically significantly increased odds of sarcopenia (p=0.020) with colorectal cancer.
Conclusion: The prevalence of sarcopenia in colorectal cancer patients was significantly higher when compared with patients with benign colorectal disease. Sarcopenia may be identified preoperatively and help identify the patients who need the optimization of nutrition and rehabilitation before colorectal surgery.

Keywords: Colorectal cancer; Sarcopenia; Skeletal muscle index; Colorectal surgery; Computed tomography; Nutritional status.

Introduction

Colorectal cancer (CRC) is a serious health issue and is one of the most common cancers in the world.[1] The latest GLOBOCAN 2024 projections indicate that around 2.04 million new colorectal cancer (CRC) cases were diagnosed and about 918,000 people died of CRC all over the world.[2] Although surgical resection has been an integral part of treatment for patients with potentially curable colorectal cancer, the nutritional and functional reserve of the patient also plays a role in postoperative recovery.[3]
Progressive decline in skeletal muscle mass with decreased muscle strength and/or physical function has become an important predictor of outcome in older patients undergoing major abdominal surgery, and is termed sarcopenia.[4] Systemic inflammation, cancer anorexia, poor nutritional intake, metabolic changes, and treatment-induced changes can all contribute to the rapid loss of skeletal muscle in CRC.[5] Importantly, sarcopenia can also be present in patients with normal or high body mass index (BMI), and traditional anthropometric parameters like body weight or BMI are not enough to detect clinically relevant muscle depletion.[6] In patients with colorectal cancer, the routine use of staging computed tomography (CT) makes the use of computed tomography (CT), especially of skeletal muscle at the third lumbar vertebral level, more common than in other patient cohorts to quantify muscle mass.[7]
Sarcopenia seems to be a significant burden among patients with CRC.[8] In a meta-analysis of 4,855 colorectal cancer patients, the prevalence of sarcopenia was reported as 34% with high inter-study heterogeneity.[9] More recent evidence indicates a yet larger burden in patients undergoing colorectal surgery. A new systematic review and meta-analysis of 40 non-randomized trials that included 13,422 patients indicated that 40.4% were determined

to be sarcopenic.[10] Sarcopenic patients were at an increased risk of 30-day postoperative morbidity, longer hospital stay, and significantly higher 30-day postoperative mortality rates than non-sarcopenic patients.[11] In line with this, very recent surgical research has shown that the presence of sarcopenia before surgery also correlates with the occurrence of complications in the postoperative period and with worse oncological results after resection of colorectal cancer.[12]

Sarcopenia's clinical significance is not just limited to the immediate postoperative period. In a systematic review and meta-analysis of 2024, researchers across eight studies found that patients with non-metastatic colorectal cancer had poorer overall survival and disease-free survival, with a hazard ratio of 1.61 and 1.57, respectively, when they were classified as sarcopenic before surgery.[13] It is concluded that reduced SMR may not only be a sign of advanced disease or malnutrition, but an important aspect of physiological vulnerability, which can affect surgical tolerability and the recovery process.

Chronic inflammation, changed food intake, intestinal dysfunction, obstruction, recurring symptoms, decreased physical activity, and nutritional deficiency can also play a role in muscle depletion, which can occur with benign colorectal diseases.[14] Thus, patients with benign colorectal disease may be used as a surgical comparison group and provide a more clinically relevant comparison of the extra burden of sarcopenia attributable to colorectal malignancy.[15] It is especially relevant to make direct comparison between sarcopenia in colorectal cancer patients and those undergoing surgery for benign colorectal diseases in resource-limited settings where routine nutritional and functional assessment is not included in the pre-surgical evaluation of the patient.[16] If colorectal cancer is found to have a higher prevalence of sarcopenia, it may provide a rationale for the implementation of easily accessible measures of muscle assessment by computed tomography as a part of the risk assessment algorithm for preoperative care.[17]

On the other hand, if it were established that there was a significant burden in benign disease, it would show that sarcopenia is not only a surgical and nutrition problem in malignancy, but it is a larger issue. A comparative approach is thus not just estimation of the prevalence of sarcopenia but an attempt to elucidate whether colorectal cancer is associated with a specific skeletal muscle depletion burden for patients undergoing colorectal surgery. Therefore, the purpose of the present study was to compare the prevalence of sarcopenia between colorectal cancer and non-cancer patients with benign colorectal diseases undergoing surgery and to investigate the clinical and demographic characteristics that might be associated with sarcopenia in both groups.

Methods

This was a comparative cross-sectional analytical study in patients who were undergoing elective colorectal surgery. This study was conducted at the department of General Surgery of Ibadat International University Hospital Rawalpindi. The study was conducted over a period of six months, from 1st March, 2025 to 31st August 2025.

The sample size was calculated using OpenEpi version 3.01 for comparison of two proportions. The prevalence of sarcopenia in patients undergoing colorectal cancer surgery was assumed to be 40.4%, as concluded in a recent meta-analysis .[9, 18] In the benign colorectal disease group, 20% was assumed as the prevalence, as good estimates for sarcopenia in the general population of patients with benign colorectal disease were scarce. The sample size was calculated with a two-sided confidence level of 95% and an 80% statistical power. The final planned sample size was 176, including 88 CRC and 88 benign colorectal disease patients.

A non-probability consecutive sampling technique was used. Patients between 18 and above years old of both sexes, who were planned for elective colorectal surgery, were included. Patients were included in the colorectal cancer group if they had a histologically confirmed colorectal adenocarcinoma or other confirmed malignant colorectal neoplasm and were to undergo surgical resection. Patients who were identified as having a non-malignant colorectal disease for which elective surgical intervention was recommended were included in the benign disease group, including those with benign strictures, complicated diverticular disease, inflammatory or structural colorectal disease, and other non-malignant surgical colorectal disease. Preoperative computed tomography (CT) scans of the abdomen had to be sufficient to assess skeletal muscle at the third lumbar vertebral level in all patients.

Patients were excluded if they had metastatic disease outside the colorectal primary site, which would have made it difficult to assess baseline muscle status; were operated upon previously for a major colorectal surgery; or were an acute surgical emergency requiring emergency operation. Surgical patients with illnesses associated with severe muscle wasting, such as advanced neuromuscular disease, were also excluded. Patients with long-term systemic

corticosteroid therapy, incomplete clinical data, and no appropriate CT images for analysis of skeletal muscle mass were excluded from the final analysis. Those who refused to participate were also excluded.

Demographic and clinical data were obtained with a structured data collection proforma after getting written informed consent. The following variables were included: age, gender, body weight, height, body mass index (BMI), smoking, comorbidities, nutritional features, presenting symptoms, diagnosis, and laboratory parameters relevant to the patient's condition. The location of the tumour, histological diagnosis, and disease stage were documented if available for patients with colorectal cancer. When the diagnosis of the colorectal disease and the indication for surgery were benign, the diagnosis was recorded.

Preoperative assessment of sarcopenia was performed on abdominal computed tomography (CT) scans. The computed tomography (CT) images acquired during a normal preoperative evaluation were evaluated at the third lumbar vertebra (L3), where the skeletal muscle cross-sectional area was quantified. The muscles of the skeletal muscle area comprised the psoas muscle, erector spinae muscle, quadratus lumborum muscle, transversus abdominis muscle, internal oblique muscle, and external oblique muscle. The measured skeletal muscle area was then divided by height in $m^{2,}$ and the result was the skeletal muscle index (SMI), which is expressed in cm^2/m^2. The L3 level CT-based assessment has been adopted for many colorectal cancer research studies to quantify the mass of the skeletal muscle.

The CT-based SMI cut-off criteria used in the selected reference standard were adopted as the definition for Sarcopenia. The same criteria for diagnosis were used for both study groups to make them comparable. A trained investigator, blinded as to the patient's study group, performed the radiological measurements, as feasible. In a subsample of images, a second evaluation was conducted to check the consistency of the measurement.

Collected data were entered, cleaned, and analyzed in IBM SPSS Statistics 26.0. The Shapiro–Wilk test was used to evaluate the normality of continuous variables. Continuous variables were reported as mean ± s.d. and median with interquartile range for non-normally distributed continuous variables. Categorical variables were presented in terms of frequencies and percentages. The prevalence of sarcopenia was computed within the colorectal cancer and benign colorectal disease groups. The primary comparison between the two groups was conducted by the Pearson chi-square test, and Fisher's exact test was used when the cell size in the table was too small for the chi-square test to be properly applied. The independent-samples t-test was used for continuous variables with normal distribution, while the Mann–Whitney U test was used for those with non-normal distribution.

Demographic, anthropometric, clinical and disease-related data were assessed for association with sarcopenia in the appropriate univariable analyses. Clinical relevance and those variables that showed $p<0.20$ in the univariable analysis were considered for multivariable binary logistic regression. Odds ratios (ORs) along with 95% confidence intervals (CIs) were presented to determine independent factors associated with sarcopenia. The adequacy of the model was checked by suitable goodness of fit measures, and multicollinearity was assessed prior to the addition of variables to the final model. A two-sided p-value <0.05 was considered to be statistically significant.

Results

A total of 176 patients undergoing colorectal surgery were included, comprising 88 patients with colorectal cancer and 88 with benign colorectal diseases. Patients with CRC were significantly older than those with benign disease, and body weight and BMI were lower. The proportion of nutritional compromise was also higher in the cancer group than in controls, but there was no significant difference in sex distribution or smoking status or overall burden of comorbidity between the groups (Table 1).

Clinical presentation was very different in the two groups. Patients with colorectal cancer reported weight loss more frequently, and bowel change more than patients with benign colorectal diseases, whereas abdominal pain was more frequent in patients with benign colorectal diseases. The most common sites of the tumors were the right colon, rectum, and left colon, and the predominant histological type was adenocarcinoma among the cancer cases. In the majority of malignant cases, diagnosis was made at stage II and III. The most common diagnosis in those with benign colorectal disease was complicated diverticular disease (Table 2).

Patients with colorectal cancer had significantly lower L3 skeletal muscle area and skeletal muscle index on CT evaluation. Of all patients with CRC, 36 (40.9%) had sarcopenia, and of all those with BCD, 18 (20.5%) had sarcopenia (Table 3), which was a statistically significant difference between the groups (p=0.003).

Sarcopenic patients were older, and the BMI was lower when compared to non-sarcopenic patients. Similarly, there was a significant relationship between sarcopenia and nutritional compromise, pre-operative weight loss and colorectal cancer diagnosis; no significant association was found with sex or smoking status (Table 4).

On univariable analysis, older age, lower BMI, nutritional compromise, weight loss, and colorectal cancer were associated with increased odds of sarcopenia. Age≥60 years, BMI <23 kg/m2, preoperative weight loss, and colorectal cancer were independent factors that remained associated with sarcopenia after multivariate adjustment. Patients with colorectal cancer had nearly 2.4-fold higher adjusted odds of sarcopenia than patients with benign colorectal disease (p=0.020) (Table 5).

Table 1. Demographic, anthropometric, and clinical characteristics of study participants (n=176)

Variable	Colorectal cancer (n=88)	Benign colorectal disease (n=88)	Test statistic	p-value
Age (years), mean ± SD	61.8 ± 11.2	55.1 ± 12.0	t=3.829	<0.001
Age group, n (%)			χ^2=6.47	0.039
18–39 years	3 (3.4)	9 (10.2)		
40–59 years	30 (34.1)	39 (44.3)		
60–79 years	48 (54.5)	36 (40.9)		
≥80 years	7 (8.0)	4 (4.5)		
Sex, n (%)			χ^2=0.58	0.447
Male	52 (59.1)	47 (53.4)		
Female	36 (40.9)	41 (46.6)		
Weight (kg), mean ± SD	64.8 ± 10.7	69.1 ± 11.5	t=-2.61	0.010
Height (m), mean ± SD	1.65 ± 0.09	1.66 ± 0.08	t=-0.78	0.438
BMI (kg/m²), mean ± SD	23.8 ± 3.8	25.1 ± 4.2	t=-2.15	0.033
BMI category, n (%)			χ^2=6.32	0.042
<18.5 kg/m²	9 (10.2)	4 (4.5)		
18.5–24.9 kg/m²	52 (59.1)	43 (48.9)		
25.0–29.9 kg/m²	22 (25.0)	31 (35.2)		
≥30 kg/m²	5 (5.7)	10 (11.4)		
Smoking status, n (%)			χ^2=2.21	0.331
Never smoker	55 (62.5)	61 (69.3)		
Former smoker	15 (17.0)	12 (13.6)		
Current smoker	18 (20.5)	15 (17.0)		
Comorbidity, n (%)			χ^2=1.74	0.187
None	49 (55.7)	58 (65.9)		
≥1 comorbidity	39 (44.3)	30 (34.1)		
Nutritional compromise, n (%)			χ^2=7.08	0.008
Present	31 (35.2)	16 (18.2)		
Absent	57 (64.8)	72 (81.8)		

Table 2. Clinical and disease characteristics of the study participants

Variable	Colorectal cancer (n=88)	Benign colorectal disease (n=88)	Test statistic	p-value
Presenting symptoms, n (%)			χ^2=11.24	0.011
Weight loss	34 (38.6)	11 (12.5)		
Altered bowel habits	39 (44.3)	27 (30.7)		
Abdominal pain	31 (35.2)	42 (47.7)		
Rectal bleeding	25 (28.4)	17 (19.3)		
Other symptoms	11 (12.5)	18 (20.5)		

Cancer site, n (%)				
Right colon	31 (35.2)			
Left colon	28 (31.8)			
Rectum	29 (33.0)			
Histological type, n (%)				
Adenocarcinoma	84 (95.5)			
Other malignant tumor	4 (4.5)			
Tumor stage, n (%)				
Stage I	12 (13.6)			
Stage II	31 (35.2)			
Stage III	34 (38.6)			
Stage IV	11 (12.5)			
Benign disease diagnosis, n (%)				
Complicated diverticular disease		27 (30.7)		
Benign colorectal stricture		18 (20.5)		
Inflammatory colorectal disease		16 (18.2)		
Colorectal polyp/other benign lesion		14 (15.9)		
Other benign surgical disease		13 (14.8)		

Table 3. CT-derived skeletal muscle measurements and prevalence of sarcopenia

Variable	Colorectal cancer (n=88)	Benign colorectal disease (n=88)	Test statistic	p-value
L3 skeletal muscle area (cm^2), mean ± SD	132.6 ± 30.4	145.8 ± 31.7	t=-2.84	0.005
Skeletal muscle index (cm^2/m^2), mean ± SD	46.7 ± 8.5	51.2 ± 8.7	t=-3.51	0.001
Sarcopenia, n (%)			χ^2=8.66	0.003
Present	36 (40.9)	18 (20.5)		
Absent	52 (59.1)	70 (79.5)		
Sex-specific sarcopenia, n (%)				
Male	21/52 (40.4)	9/47 (19.1)	χ^2=5.37	0.020
Female	15/36 (41.7)	9/41 (22.0)	χ^2=3.53	0.060

Table 4. Comparison of demographic and clinical characteristics according to sarcopenia status

Variable	Sarcopenia present (n=54)	Sarcopenia absent (n=122)	Test statistic	p-value
Age (years), mean ± SD	64.2 ± 10.4	55.8 ± 11.9	t=4.58	<0.001
Male sex, n (%)	30 (55.6)	69 (56.6)	χ^2=0.01	0.925
BMI (kg/m^2), mean ± SD	22.9 ± 3.5	25.1 ± 4.1	t=-3.47	0.001
Current smoking, n (%)	12 (22.2)	21 (17.2)	χ^2=0.64	0.423
≥1 comorbidity, n (%)	27 (50.0)	42 (34.4)	χ^2=3.85	0.050
Nutritional compromise, n (%)	21 (38.9)	26 (21.3)	χ^2=5.87	0.015
Weight loss, n (%)	23 (42.6)	22 (18.0)	χ^2=11.43	0.001
Colorectal cancer, n (%)	36 (66.7)	52 (42.6)	χ^2=8.66	0.003

Table 5. Factors associated with sarcopenia on univariable and multivariable logistic regression analysis

Variable	Univariable OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age ≥60 years	2.84 (1.42–5.67)	0.003	2.31 (1.10–4.85)	0.027
Male sex	0.96 (0.49–1.88)	0.925	0.91 (0.44–1.89)	0.800
BMI <23 kg/m²	2.47 (1.27–4.80)	0.008	2.08 (1.02–4.24)	0.044
Current smoking	1.37 (0.61–3.07)	0.424	1.18 (0.49–2.85)	0.713
≥1 comorbidity	1.91 (0.98–3.71)	0.057	1.54 (0.75–3.17)	0.240
Nutritional compromise	2.34 (1.11–4.92)	0.026	1.96 (0.88–4.38)	0.098
Weight loss	3.37 (1.57–7.23)	0.002	2.71 (1.19–6.17)	0.017
Colorectal cancer	2.67 (1.32–5.39)	0.006	2.43 (1.15–5.14)	0.020

Discussion

In the present study, it was found that the prevalence of sarcopenia was significantly higher in patients undergoing surgery for colorectal cancer compared to those with surgery for benign colorectal disease (p=0.003). The finding is consistent with the hypothesis that the burden of skeletal muscle depletion is greater with colorectal malignancy than with benign colorectal pathology. Notably, the prevalence of 40.9% in the cancer group was very close to the prevalence of 40.4% in a 2025 systematic review and meta-analysis of 13,422 patients who underwent colorectal cancer surgery. That meta-analysis also illustrated that in the surgical population, there is a link between morbidity and mortality and the presence of sarcopenia.[10]

Our results also agreed with the systematic review and meta-analysis performed by Trejo-Avila et al. in 2021, in which 44 observational studies involving 18,891 patients with CRC were included, and a pooled prevalence of 37% of sarcopenia was reported. There might be a higher prevalence in our cancer population than in the general population, which could be related to the different population characteristics, nutritional status, age distribution, CT diagnosis thresholds, or surgery selection. Importantly, they showed that their analysis revealed that postoperative complications, mortality, longer hospital stays, and worse overall and disease-free survival were associated with sarcopenia, underscoring the significance of detecting sarcopenia before colorectal surgery.[19]

A 2023 meta-analysis of 4,855 patients also found a pooled prevalence of sarcopenia in CRC of 34%. This prevalence was within the range of that reported in the recent literature, even though the prevalence in our comparison group with benign disease was much lower. Reduced skeletal muscle reserve may thus be considered as one crucial marker of biological vulnerability in colorectal malignancy, as revealed by the same meta-analysis, which also demonstrated that sarcopenia is linked to worse overall, disease-free, and cancer-specific survival.[9]

Our findings were specifically similar to a study of 209 patients undergoing laparoscopic colorectal cancer surgery in 2022 in which 41.1% were found to have sarcopenia. The close similarity in cancer prevalence further validates the consistency of our results between these two approaches and population groups. In that study, however, several outcomes like surgical-site infection were also not impacted, but there was an increase in severe postoperative complications and readmission in the sarcopenic patients.[20]

Likewise, a study by Chai et al. in 2021 showed that sarcopenia is a significant prognostic factor for post-curative colorectal cancer resection clinical and oncological outcomes. Their conclusions corroborate our work, which has suggested that sarcopenia should not be treated as a mere radiological finding, but rather as a clinically relevant feature of patients undergoing colorectal surgery. The high prevalence of sarcopenia in our colorectal cancer population is also consistent with other surgical cohorts, further indicating the generalizability of the observed high prevalence of sarcopenia across different healthcare environments.[21]

The lower skeletal muscle measurements observed in our colorectal cancer group were also in agreement with studies using CT-derived muscle assessment. The skeletal muscle mass measured by computed tomography (CT) at the level of L3 has emerged as a useful and reliable index of skeletal muscle quantity, and is often available in the preoperative setting, making this a valuable tool for the assessment of skeletal muscle mass in colorectal cancer. In 2021, a large, longitudinal study identified preoperative sarcopenia in 49.5% of patients with CRC and showed that persistent or postoperative sarcopenia were linked to worse long-term oncological outcomes.[21]

Age was another important factor in our study. Patients with sarcopenia were significantly older than those without sarcopenia, and multivariable adjustment did not exclude age ≥60 years from the association with sarcopenia. This

observation is biologically plausible because skeletal muscle mass and strength naturally decrease as people age. It is also noteworthy that in a prospective study (2026) of 70 patients with colorectal cancer, a more extensive EWGSOP2 definition identified patients who were significantly older and had lower levels of BMI and serum albumin.[22]

We also found a significant association between lower BMI and sarcopenia, which was similar to what is observed in the current literature. BMI less than 23 kg/m² was independently associated with sarcopenia even after controlling for other factors in this cohort. The prospective EWGSOP2 study in 2026 also showed that patients with sarcopenia had a lower BMI. This correlation underscores the value of nutritional and anthropometric evaluation, but BMI shouldn't be used as the only criterion to diagnose sarcopenia since weight loss can occur without a significant decrease in body weight.[23]

In our analysis, another independent predictor was pre-operative weight loss; the patients who reported weight loss had significantly higher odds of sarcopenia. This finding aligns with the theory of cancer-associated catabolism, which states that progressive depletion of skeletal muscle is driven by reduced food consumption, systemic inflammation, and metabolic changes, as well as the presence of cancer. A further study from 2022 showed that postoperative muscle loss was clinically significant: those who had sarcopenia had worse postoperative outcomes and longer hospital stays, and more postoperative muscle loss was associated with worse overall and disease-free survival independently.[23]

This is particularly relevant because we observed colorectal cancer to be an independent factor of sarcopenia even after adjusting for age, BMI, weight loss, nutritional status, smoking, and comorbidities. It was proposed that the increased prevalence found in the cancer group was due to more than just older age or poorer nutritional status. Instead, the cancerous disease may actually add more catabolic and inflammatory effects that cause muscles to be lost. It is also supported by the general surgical literature, which includes the 2025 meta-analysis which revealed a significant burden of sarcopenia in patients undergoing curative surgical treatment for colorectal cancer.[10]

Limitations

There were several limitations with this study. It was a cross-sectional design, which restricted the evaluation of temporal and causal relationships between colorectal cancer and sarcopenia. The study was undertaken in one centre, and the sample size is relatively small, which may restrict the generalisability of the results. Sarcopenia was evaluated based on CT-derived skeletal muscle measures, without taking into account muscle strength and physical performance, although these are incorporated in more recent definitions, such as those in EWGSOP2. Benign colorectal diseases were also grouped, and could have contained clinical variation. Further, there were no adequate measurements of potential confounding factors related to diet, inflammatory markers, physical activity and socioeconomic status. Larger prospective studies, and those including both muscle quantity and functional measures, are therefore warranted.

Conclusion

Patients who had undergone surgery for CRC were significantly more likely to have sarcopenia than patients who had undergone surgery for other benign colorectal diseases. Sarcopenia was independently associated with older age, lower BMI, preoperative weight loss, and colorectal cancer. These results underscore the need to be aware of the occurrence of skeletal muscle depletion in colorectal surgical patients during the preoperative evaluation process. Sarcopenia screening may be included as a part of the routine surgical assessment as a tool to identify patients with low physiological reserve, who may be suitable for nutritional optimization or preoperative rehabilitation.

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