RESEARCH ARTICLE

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Malnutrition in Colorectal Cancer Patients: Association with the Lack of Eating Motivation and Inappropriate Diet

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Abstract

Objective: Colorectal cancer (CRC) significantly contributes to cancer-related mortality in Vietnam. Notably, malnutrition, rather than cancer itself, accounts for one-fifth of the deaths among cancer patients. Therefore, understanding the nutritional status and related factors among CRC patients is essential. We aimed to investigate the nutritional status and related factors in CRC in Vietnam. **Methods:** This cross-sectional study, conducted from October 2022 to April 2023, included CRCs of both sexes aged ≥18 years. Data collection involved face-to-face interviews, anthropometric assessments, and medical record reviews. Nutritional status was evaluated using the Patient-Generated Subjective Global Assessment (PG-SGA). Multivariable logistic regression was used to identify malnutrition-related factors. **Results:** In total, 388 patients were included (median age, 60.0 years, [IQR: 51.0–66.0 years]; men, 57.7%). The prevalence of malnutrition was 87.9% (95%CI: 84.6-91.1), and urgent nutritional intervention was needed in 64.7% of participants. Malnutrition-associated factors included lack of eating motivation (OR=8.76, 95%CI: 1.81-42.38), dieting for fear of cancer cell growth (OR=3.82, 95%CI: 1.27-11.52), gastrointestinal symptoms (OR=5.38, 95%CI: 1.76-16.45), daily energy intake <25kcal/kg (OR=7.02, 95%CI: 1.70-28.99), protein ≤ 1g/kg (OR=5.21, 95%CI: 1.32-20.60), fat <18% of total energy intake (OR=3.13, 95%CI: 1.02-9.57), mean corpuscular volume <85fL (OR=4.74, 95%CI: 1.11-20.22), and total lymphocyte count ≤1700 lymphocytes/mm^3 (OR=4.06, 95%CI: 1.22-13.50). Additionally, a 1-kg increase in dominant hand strength reduced the risk of malnutrition by 4% (OR=0.96, 95%CI: 0.93-0.99). **Conclusion:** The high prevalence of malnutrition among CRCs in Vietnam necessitates nutritional intervention. The main contributors include loss of eating motivation and inadequate dietary intake.

Keywords: Colorectal cancer- malnutrition- motivation- diet- protein

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Introduction

Colorectal cancer is the most common type of digestive system cancer. CRC is third in terms of new cases, and in terms of deaths, it ranked second after lung cancer [1]. Recently, CRC was ranked fifth in terms of both new cases and deaths in Vietnam. It accounted for 9% of all new cases and 6.9% of deaths [2]. Cancer patients are among the most malnourished patients in hospitals, accounting for 71% [3]. Moreover, patients who die from malnutrition before developing cancer account for 20% of all cancer patients [4].

Early detection and prevention of malnutrition in cancer patients are crucial to help patients stay healthy, reduce anemia, increase responsiveness to chemotherapy drugs, complete treatment regimens early and improve quality of life [5]. However, many patients fear that food consumption may exacerbate or trigger cancer development or recurrence. Consequently, they significantly restrict their diet, leading to weight loss and a worsening of nutritional status. Previous studies indicate that 50-80% of cancer patients fail to meet the recommended dietary requirements for energy and energy-producing substances [6, 7]. Additionally, during treatment, patients often experience anxiety and struggle with the adverse effects of radiation and chemotherapy drugs. These factors also contribute to loss of appetite and fatigue, further leading to a lack of motivation to eat.

Identifying the factors related to malnutrition to help prevent and mitigate malnutrition in cancer patients is

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crucial. Previous studies have identified factors related to malnutrition in cancer patients, such as age, sex, gastrointestinal symptoms, hand grip strength (HGS), anemia, decreased lymphocyte count, and albumin level [8-11]. However, the factors related to the patients' motivation to eat and dietary habits remain unclear. Furthermore, most of these studies were conducted in developed countries, and data from developing countries are limited. This study aimed to comprehensively evaluate the nutritional status of CRC patients in Vietnam and identify the factors associated with malnutrition.

Materials and Methods

Study design and participants

We conducted a cross-sectional study of patients with CRC who sought examination and treatment at an Oncology Hospital in Vietnam from October 2022 to April 2023. The sample size was calculated according to the one ratio estimation formula with d=0.05, $Z_{(1-\alpha/2)}$=1.96, and p=30.9% of the malnutrition rate in CRC patients according to a study by Ræder et al. [12]. The minimum sample size for this study was 329 CRC patients. We used a nonprobability convenience sampling method. CRC patients diagnosed via pathology (diagnostic code: C18-C20/C21 according to the International Classification of Diseases, 10th Revision) aged ≥18 years who underwent examination and treatment at the hospital were eligible to participate in our study. The exclusion criteria were mental illnesses or cognitive disorders, inability to eat due to medical conditions, inability to answer interview questions, and refusal to participate in the study.

Measurements

Nutritional status

We used the PG-SGA questionnaire to collect nutritional information through face-to-face interviews. PG-SGA is a tool with excellent diagnostic ability, high accuracy (sensitivity: 88.6-98%, specificity: 82-100%), internal consistency (Cronbach's alpha: 0.722-0.73), and strong test-retest reliability (r=0.866) [13]. It is considered the gold standard for assessing the nutritional status of cancer patients. Nutritional status was classified into three levels: PG-SGA A (well-nourished), PG-SGA B (moderate/suspected malnutrition), and PG-SGA C (severely malnourished) [14]. In the present study, malnutrition was defined as PG-SGA B or C.

The level of nutritional intervention is planned based on the total PG-SGA score, as follows: 0-1 point, no intervention required at this time with reassessment on a routine basis during treatment; 2-3 points, patient and family education by dietitian, nurse, or other clinician with pharmacologic intervention as indicated by symptoms and test results; 4-8 points, require intervention delivered by dietitian, in conjunction with nurse or physician as indicated by symptoms; and ≥9 points, need for improved symptom management and/or nutrient intervention options [15].

Dietary intake, laboratory analysis and clinical information

The 24h dietary information of the participants was collected through face-to-face interviews. The variables associated with the patient's 24h nutritional intake included energy, protein, % fat, and % carbohydrate. Here, % fat was calculated as (grams of fat intake in 24h*100*9)/ total energy intake in 24h, and % carbohydrate was calculated as (number of grams of carbohydrate consumed in 24h*4*100)/total energy intake in 24h [16-18].

The laboratory results that were collected included hemoglobin levels, mean corpuscular volume (MCV), and total lymphocyte count (TLC) [11, 19, 20]. Clinical data, including the location of the initial cancer, stage of disease, recurrence, current treatment modality, and comorbidities, were extracted from the patient's medical records.

Physical strength assessment and eating motivation

An electronic scale was used to measure the patient's weight. Mid-upper arm circumference (MUAC) was measured at the midpoint between the acromion and olecranon processes on the shoulder blade and the ulna on the left arm using a flexible non-stretchable tape with 0.1 cm precision. The dominant HGS was measured using a Jama Dynamometer (A7191, Patterson Medical, Australia). The variation in eating motivation was assessed scores of 0-1 indicated a lack of motivation, while those of 2-3 indicated that the patient was motivated [21, 22].

Statistical analysis

Data were imported and managed using Epidata software (version 3.1, Epidata Association). All statistical analyses were performed using R software (version 4.3.2, R Foundation for Statistical Computing, Austria) and RStudio (version 2023.06.2, Build 561, Posit Software, PBC, USA). We also used the Vietnam Eiyoukun software to calculate energy, protein, fat, and carbohydrate intake based on the patient's 24h dietary intake [23]. Qualitative variables are summarized as frequency and percentage, whereas quantitative variables are presented as mean and standard deviation (SD) or median and interquartile range (IQR). We used the chi-square and Mann–Whitney U tests to compare the demographic characteristics of the study participants by sex. We also used the chi-square test, t-test, and Mann–Whitney U test to compare clinical characteristics; paraclinical characteristics; eating motivation; daily energy intake; and protein, fat, and carbohydrate consumption by disease stage. Additionally, the chi-square test, t-test, and Mann–Whitney U test were used to identify factors related to malnutrition. All variables with a p-value ≤0.2 in the univariate analysis were included in the multivariate logistic regression analysis [24], in which odd ratio (OR) and 95% confidence intervals (CIs) were estimated. Irrelevant variables were gradually removed from the model step-by-step. Stepwise backward selection was used to create the final model to identify the factors associated with malnutrition in CRC patients. We also compared the old and new models using the likelihood ratio test with p>0.05 and found no difference between the two models. Statistical significance was set at a two-sided p<0.05.

Results

Characteristics of study participants

Of the 393 CRC patients initially enrolled, 388 met the study requirements and were included in the subsequent statistical analysis. Table 1 shows that the median age of the study participants was 60.0 years (IQR: 51.0-66.0), men accounted for 57.7% of the participants, and 78% were married. Most participants came from other provinces and cities (87.1%); the Kinh ethnic group accounted for 96.9% of participants. The proportion of participants with education levels lower than primary school was 30.9%. Regarding occupation, farmers and workers accounted for 31.2% of participants, and 46.4% had no income. Significant differences were observed in age, occupation, income, and marital status between men and women ($p<0.05$).

Regarding the location of cancer, 49.5% of patients had colon cancer, 44.8% had rectal cancer, and 5.7%, had CRC. Patients with stage III to IV cancer accounted for 82.7% of the participants. The rate of cancer recurrence was 15.2%. Regarding the treatment administered, 56.2% and 18.5% of participants received chemotherapy and surgery, respectively. Patients with comorbidities accounted for 45.4% of the participants.

The MUAC was 23.61±3.24 cm. The median dominant HGS was 40.9 kg (IQR: 31.3-52.0). Regarding paraclinical indicators, low hemoglobin levels (men: <130 g/L, women: <120 g/L) were seen in 63.4% of patients, MCV<85 fL in 27.3%, and TCL≤1700 lymphocytes/mm^3 in 51.3%.

Table 2 shows that 59.3% of patients lacked the motivation to eat, and 61.1% were dieting for fear of consuming nutrients that would cause the growth of cancer cells. Furthermore, stage III and IV patients had a higher rate of disease recurrence and lower arm circumference than that in stage I and II patients ($p<0.05$).

Table 3 shows the following proportions of patients based on nutrient intake: energy intake <25 kcal/kg/24h, 67.8%; protein≤1 g/kg/24h, 70.1%; fat<18% of the total energy intake/24h, 71.1%; and carbohydrate <60% of the total energy intake/24h, 71.7%. There were no significant differences in the 24h dietary intake of energy, protein, fat, and carbohydrate between the two groups of patients based on disease stages ($p>0.05$).

Classification of nutritional status in CRC patients

Figure 1 shows that the malnutrition rate in CRC patients was 87.9% (95%CI: 84.6-91.1). Of these, 61.3% of patients had mild and moderate malnutrition, whereas 26.6% had severe malnutrition. There was no significant difference between malnutrition and disease stages among

Table 1. Demographic Characteristics of Study Participants (n=388)

Characteristics	Overall n (%)	Male n (%)	Female n (%)	p-value
N	388 (100.0)	224 (57.7)	164 (42.3)	
Age, (Median, IQR)	60.0 (51.0-66.0)	61 (55-68)	55.5 (44.5-65.0)	<0.001*
Place of residence				
Other provinces/cities	338 (87.1)	198 (88.4)	140 (85.4)	0.379†
Ho Chi Minh City	50 (12.9)	26 (11.6)	24 (14.6)	
Ethnicity				
Kinh	376 (96.9)	214 (95.5)	162 (98.8)	0.068†
Other	12 (3.1)	10 (4.5)	2 (1.2)	
Education level				
≤Primary school	120 (30.9)	64 (28.6)	56 (34.1)	
Secondary school/high school	239 (61.6)	142 (63.4)	97 (59.2)	0.484†
Intermediate/college/university/post-graduate	29 (7.5)	18 (8.0)	11 (6.7)	
Occupation				
Farmer/worker	121 (31.2)	83 (37.1)	38 (23.2)	
Officer/civil servant	58 (15.0)	31 (13.8)	27 (16.5)	
Retired/unemployed	101 (26.0)	71 (31.7)	30 (18.3)	<0.001†
Other (housewife, construction worker, motorbike taxi, seafarer)	108 (27.8)	39 (17.4)	69 (42.0)	
Average monthly income (VND)				
No income	180 (46.4)	90 (40.2)	90 (54.9)	
<5 million	141 (36.3)	91 (40.6)	50 (30.5)	0.016†
≥5 million	67 (17.3)	43 (19.2)	24 (14.6)	
Marital status				
Married	303 (78.1)	192 (85.7)	111 (67.7)	<0.001†
Single/separated/divorced/widowed	85 (21.9)	32 (14.3)	53 (32.3)	

*, Mann–Whitney U test; †, Chi-square test; IQR, interquartile range; VND, Vietnam Dong

Table 2. Clinical and Paraclinical Characteristics and Eating Motivation by Disease Stage (n=388)

Characteristics	Overall n (%)	Disease stage n (%)		p-value
		Stages I-II	Stages III-IV	
N	388 (100.0)	67 (17.3)	321 (82.7)	
Location of initial cancer				
Colon	192 (49.5)	41 (61.2)	151 (47.0)	0.108*
Rectum	174 (44.8)	23 (34.3)	151 (47.0)	
Colorectal	22 (5.7)	3 (4.5)	19 (6.0)	
Recurrence				
No	329 (84.8)	63 (94.0)	266 (82.9)	0.021*
Yes	59 (15.2)	4 (6.0)	55 (17.1)	
Current treatment status				
Preparation for treatment	25 (6.4)	2 (3.0)	23 (7.2)	0.100*
Surgery	72 (18.5)	18 (26.9)	54 (16.8)	
Chemotherapy	218 (56.2)	35 (52.2)	183 (57.0)	
Radiotherapy	60 (15.5)	12 (17.9)	48 (14.9)	
Palliative care	13 (3.4)	0 (0.0)	13 (4.1)	
Comorbidities				
Yes	212 (54.6)	39 (58.2)	173 (53.9)	0.519*
No	176 (45.4)	28 (41.8)	148 (46.1)	
MUAC (cm); (Mean±SD)	23.61±3.24	24.56±2.92	23.41±3.28	0.008†
Dominant HSG (kg), (Median, IQR)	40.9 (31.3-52.0)	44.6 (31.4-54.4)	40.2 (31.2-51.0)	0.194‡
Hemoglobin				
Male ≥130g/L and female ≥120g/L	142 (36.6)	30 (44.8)	112 (34.9)	0.127*
Male <130g/L and female <120g/L	246 (63.4)	37 (55.2)	209 (65.1)	
Mean corpuscular volume (fL)				
≥85fL	282 (72.7)	50 (74.6)	232 (72.3)	0.694*
<85fL	106 (27.3)	17 (25.4)	89 (27.7)	
Total lymphocyte count				
>1,700 lymphocytes/mm^3	189 (48.7)	32 (47.8)	157 (48.9)	0.864*
≤1,700 lymphocytes/mm^3	199 (51.3)	35 (52.2)	164 (51.1)	
Lack of eating motivation				
No	158 (40.7)	33 (49.3)	125 (38.9)	0.118*
Yes	230 (59.3)	34 (50.7)	196 (61.1)	
Dieting for fear of consuming nutrients that would cause the growth of cancer cells				
No	151 (38.9)	30 (44.8)	121 (37.7)	0.280*
Yes	237 (61.1)	37 (55.2)	200 (62.3)	
Gastrointestinal symptoms				
No	50 (12.9)	9 (13.4)	41 (12.8)	0.883*
Yes	338 (87.1)	58 (86.6)	280 (87.2)	

*, Chi-square test; †, t-test; ‡, Mann–Whitney U test; SD, standard deviation; IQR, interquartile range; MUAC, Mid-Upper Arm Circumference; HSG, hand grip strength

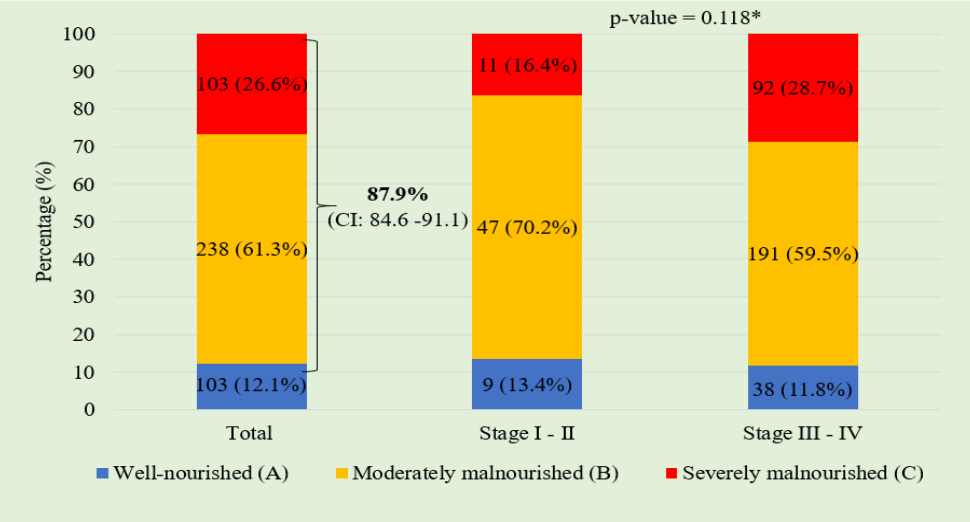
CRC patients (p>0.05).

The results of this study also show that 64.7% of CRC patients required nutritional intervention, whereas 23.2% of symptomatic patients required intervention by a dietitian in conjunction with a nurse or physician and 10.0% of patients required pharmacological intervention based on symptoms and laboratory results.

Factors associated with malnutrition in CRC patients

The univariate analysis (Table 4a, 4b) revealed that factors related to malnutrition in CRC patients included education level; MUAC; hemoglobin; dominant HGS; MCV; TCL; lack of eating motivation; dieting for fear that nutrients would cause the growth of cancer cells; gastrointestinal symptoms; and energy, protein, fat, and carbohydrate intake within 24h (p<0.05).

The multivariable logistic regression analysis showed that patients whose dominant HGS increased by 1 kg had a 4% reduced risk of malnutrition (OR= 0.96, 95%CI: 0.93-0.99; Table 5). Patients with MCV<85 fL (OR=4.74,



Chi-square test, comparison of nutritional status between the 2 groups of CRC patients in stages I-II and II-IV; CI: Confidence interval

Figure 1. Classification of Malnutrition According to the PG-SGA by Disease Stage (n=388)

95%CI: 1.11-20.22) and those with a TLC≤1700 lymphocytes/mm^3 (OR= 4.06, 95%CI: 1.22-13.50) were higher risk of malnutrition, respectively.

Patients who lacked the motivation to eat (OR= 8.76, 95%CI: 1.81-42.38), were dieting for fear of cancer cell growth (OR= 3.82, 95%CI: 1.2711.52), and had gastrointestinal symptoms (OR= 5.38, 95%CI: 1.76-16.45) were higher risk of being malnourished, respectively. Additionally, patients with an energy intake of <25 kcal/kg of body weight/24h (OR= 7.02, 95%CI: 1.70-28.99) and those who ate ≤1 g of protein/kg/24h (OR= 5.21, 95%CI: 1.32-20.60) were higher risk of malnutrition, respectively. Patients' whose dietary intake of fat was <18% of the total energy intake in 24h had a 3.13 times higher risk of malnutrition than did those whose dietary intake was above this level (OR= 3.13, 95%CI: 1.02-9.57).

Discussion

The main findings of this study were a high prevalence of malnutrition at 87.9% and a significant need for nutritional intervention at 64.7%. Factors associated with malnutrition included lack of motivation to eat, inappropriate diet due to dieting for fear of cancer cell growth, daily energy intake <25 kcal/kg, protein intake ≤1 g/kg, and fat intake <18% of total energy intake. Some laboratory indicators were also associated with malnutrition, such as MCV<85 fL and TLC≤1700 lymphocytes/mm^3. Additionally, CRC patients with gastrointestinal symptoms had an increased risk of malnutrition. Conversely, a 1-kg increase in dominant HGS reduced the risk of malnutrition by 4%.

Our study revealed a high prevalence of malnutrition in CRC patients and an urgent need for nutritional intervention. Similar to the results of previous studies

Table 3. Daily Energy Intake and Protein, Fat, and Carbohydrate Consumption (n=388)

24-h diet	Overall n (%)	Disease stage n (%)		p-value
		Stages I-II n (%)	Stages III-IV n (%)	
Energy				
≥25kcal/kg/24h	125 (33.2)	22 (32.8)	103 (32.1)	0.905*
<25kcal/kg/24h	263 (67.8)	45 (67.2)	218 (67.9)	
Protein				
>1g/kg/24h	116 (29.9)	19 (28.4)	97 (30.2)	0.762*
≤1g/kg/24h	272 (70.1)	48 (71.6)	224 (69.8)	
Fat				
≥18%	112 (28.9)	18 (26.8)	94 (29.3)	0.691*
<18%	276 (71.1)	49 (73.1)	227 (70.7)	
Carbohydrate				
≥60%	110 (28.3)	19 (28.4)	91 (28.4)	0.999*
<60%	278 (71.7)	48 (71.6)	230 (71.6)	

*, Chi-square test

Table 4a. Factors associated with Malnutrition, Univariate Analysis (n=388)

Factors	Malnutrition		p-value
	Yes n (%)	No n (%)	
Age, (Median, IQR)	59 (51-63)	60 (51-69)	0.315*
Sex			
Male	197 (87.9)	27 (12.1)	0.966†
Female	144 (87.8)	20 (21.2)	
Education level			
≤Primary school	112 (93.3)	8 (6.7)	0.022†
Secondary school/high school	207 (86.6)	32 (13.4)	
Intermediate/college/university/post-graduate	22 (75.9)	7 (24.1)	
Occupation			
Farmer/worker	110 (90.9)	11 (9.1)	0.289†
Officer/civil servant	47 (81.0)	11 (19.0)	
Retired/unemployed	88 (87.1)	13 (12.9)	
Other (housewife, construction worker, motorbike taxi)	96 (88.9)	12 (11.1)	
Average monthly income (VND)			
No income	159 (88.3)	21 (11.7)	0.737†
<5 million	125 (88.6)	16 (11.4)	
≥5 million	57 (85.1)	10 (14.9)	
Marital status			
Married	263 (86.8)	40 (13.2)	0.215†
Single/separated/divorced/widowed	78 (91.8)	7 (8.2)	
Comorbidities (hypertension/diabetes/kidney failure/liver failure/heart failure)			
Yes	185 (87.3)	27 (12.7)	0.680†
No	156 (88.6)	20 (11.4)	
Stage of disease			
I-II	58 (86.6)	9 (13.4)	0.716†
III-IV	283 (88.2)	38 (11.8)	
MUAC (cm), (Mean±SD)	23.4±3.3	25.2±2.2	<0.001‡
Strength of dominant hand (kg), (Median, IQR)	38.8 (29.6-49.8)	52 (48-58)	0.021*

*, Mann–Whitney U test; †, Chi-square test; ‡, t-test; VND, Viet Nam Dong; SD, standard deviation; IQR, interquartile range; MUAC, Mid-upper arm circumference

conducted in Vietnam and the Philippines, malnutrition rates ranged from 76.4-85.7% [25, 26]. However, our results showed higher values than those of previous studies in Canada, China and Korea that used the same PG-SGA questionnaire, with the proportion of patients with malnutrition ranging from 39.9-60.9% [27-29]. Additionally, the urgent need for nutritional intervention in our study was also higher than that reported in studies in developed countries (17.3-23.5%) [27, 28]. These disparities may be related to the cancer stage. Our study found that 82.7% of participants were in advanced stages (III-IV), which may contribute to the higher prevalence of malnutrition due to the physiological burden of the disease and treatment side effects. In addition, economic and healthcare constraints may exacerbate this problem in Vietnam compared to developed countries. Furthermore, access to specialist nutrition support remains limited in Vietnam, and awareness of nutrition as an essential part of cancer treatment is low among both patients and clinicians. Notably, a previous study found that only 12.6% of malnourished cancer patients at a Vietnamese cancer hospital received nutrition counselling [30]. These findings highlight the need for routine malnutrition screening and timely intervention in Vietnam's cancer care. Integrating nutritional assessments into hospital admissions, training healthcare professionals to use the PG-SGA tool, and developing annual nutrition programs for cancer patients is essential to enhance treatment outcomes, quality of life, and survival.

The present study identified various important factors related to malnutrition in CRC patients, including lack of motivation to eat, inappropriate eating habits such as dieting for fear that eating nutrients would lead to cancer cell growth, and low daily energy and nutrient intake. These findings have not been reported previously. These factors can be improved through nutritional counselling and encouragement to help patients understand that an adequate diet will improve their malnutrition, reduce anemia, increase the effectiveness of treatment regimens, and improve quality of life [5]. According to

Table 4b. Factors Associated with with Malnutrition, Univariate Analysis (n=388)

Factors	Malnutrition		p-value
	Yes n (%)	No n (%)	
Hemoglobin			
Male ≥130g/L and female ≥120g/L	116 (81.7)	26 (18.3)	0.004†
Male <130g/L and female <120g/L	225 (91.5)	21 (8.5)	
Mean corpuscular volume			
≥8fL	241 (85.5)	41 (14.5)	0.017†
<85 fL	100 (94.3)	6 (5.7)	
Total lymphocyte count			
>1,700 lymphocytes/mm^3	157 (83.1)	32 (16.9)	0.005†
≤1,700 lymphocytes/mm^3	184 (92.5)	15 (7.5)	
Lack of eating motivation			
No	114 (72.1)	44 (27.9)	<0.001†
Yes	227 (98.7)	3 (1.3)	
Dieting for fear of consuming nutrients that would cause the growth of cancer cells			
No	118 (78.1)	33 (21.9)	<0.001†
Yes	223 (94.1)	14 (5.9)	
Gastrointestinal symptoms			
No	26 (52.0)	24 (48.0)	<0.001†
Yes	315 (93.2)	23 (6.8)	
Energy			
≥25kcal/kg/24h	85 (68.0)	40 (32.0)	<0.001†
<25kcal/kg/24h	256 (97.3)	7 (2.7)	
Protein			
>1g/kg/24h	74 (63.8)	42 (36.2)	<0.001†
≤1g/kg/24h	267 (98.2)	5 (1.8)	
Fat			
≥18%	79 (70.5)	33 (29.5)	<0.001†
<18%	262 (94.9)	14 (5.1)	
Carbohydrate			
≥60%	85 (77.3)	25 (22.7)	<0.001†
<60%	256 (92.1)	22 (7.9)	

†, Chi-square test

the recommendations of the ESPEN, adequate nutrition does not promote tumor growth. The hypothesis that nutrients "feed the tumor" is unsubstantiated; therefore, this hypothesis should not be used as a reason to refuse to eat, reduce the intake of food, or stop feeding cancer patients [18].

Our study found additional factors associated with malnutrition, such as gastrointestinal symptoms, MCV<85 fL, TLC≤1700 lymphocytes/mm^3, and reduced dominant HGS. This result is consistent with previous studies showing that patients with gastrointestinal symptoms are more likely to lose weight and have a higher risk of malnutrition [8, 25]. MCV <85 fL indicates microcytic anemia, which may be caused by tumor bleeding, poor nutrition, or chronic inflammation [31, 20]. In addition, cancer patients with blood lymphocyte counts ≤1700 cells/mm^3 have a higher risk of malnutrition [25]. Moreover, HSG is a measure of muscle strength commonly assessed by a dynamometer, and it is also an early marker to evaluate nutritional status, detecting before changes in anthropometric and biochemical shifts [32]. The decreased HGS indicates that malnutrition in cancer patients is also significantly increased due to decreased lean muscle mass, leading to reduced muscle strength [10, 33]. These predictive factors can be used with other tools to screen for and detect malnutrition early in cancer patients.

Our study had some limitations. Firstly, there is the possibility of recall bias when interviewing patients to determine their 24h diets. Corrective measures were taken using books with pictures of food, drinks, cups, bowls, spoons, bottles, and cans to help patients easily remember and measure their food intake. Secondly, measurement errors may have occurred when patients' weight, MUAC, and HGS were measured. We attempted to avoid these errors by calibrating tools after each measurement; moreover, each patient underwent measurement twice, and the average of the results of the two measurements was analyzed.

Table 5. Factors Related to Malnutrition in CRC Patients in the Multivariable Logistic Regression Analysis (n=388)

Factors	OR crude (CI 95%)	OR multivariable adjusted (CI 95%)
Education		
Secondary school and high school vs ≤primary school	0.46 (0.21-1.04)	0.38 (0.11-1.31)
Intermediate/college/university/post-graduate vs ≤ primary school	0.22 (0.70-0.68)	1.36 (0.20-9.28)
Mid-upper Arm Circumference (cm)	0.84 (0.76-0.92)	0.87 (0.70-1.09)
Hemoglobin (g/l)		
Men <130 and women <120 vs men ≥130 and women ≥120	2.40 (1.29-4.45)	1.49 (0.49-4.58)
Dominant hand strength (kg)	0.95 (0.93-0.96)	0.96 (0.93-0.99)
Mean corpuscular volume (fL)		
<85 vs ≥85	2.84 (1.17-6.89)	4.74 (1.11-20.22)
Total lymphocyte count (lymphocytes/mm^3)		
≤1700 vs >1700	2.50 (1.30-47.9)	4.06 (1.22-13.50)
Lack of eating motivation		
Yes vs no	29.20 (8.89-96.09)	8.76 (1.81-42.38)
Dieting for fear of eating nutrients will cause the growth of cancer cells		
Yes vs no	4.45 (2.29-8.65)	3.82 (1.27-11.52)
Gastrointestinal symptoms		
Yes vs no	12.64 (6.29-25.40)	5.38 (1.76-16.45)
Energy intake (kcal/kg/24 hours)		
< 25 vs ≥ 25	17.21 (7.43-39.85)	7.02 (1.70-28.99)
Protein intake (g/kg/24 hours)		
≤1 vs >1	30.3 (11.58-79.34)	5.21 (1.32-20.60)
Fat (%)		
<18 vs ≥18	7.81 (3.98-15.34)	3.13 (1.02-9.57)
Carbohydrate (%)		
<60 vs ≥60	3.42 (1.84-6.38)	2.91 (0.86-9.84)

OR, odds ratio; CI, confidence interval

In conclusion, the present study reports a high prevalence of malnutrition in CRC patients and suggests an urgent need for nutritional interventions. Factors associated with malnutrition include a lack of motivation to eat, dieting for fear of cancer cell growth, gastrointestinal symptoms, and diet not meeting recommendations. Thus, clinicians and nutrition specialists should be aware of the risk of malnutrition and the need for nutritional intervention and counselling in CRC patients, in which attention should be paid to factors that motivate and encourage patients to have an appropriate diet to prevent, improve malnutrition and enhance the effectiveness of cancer treatment.

Author Contribution Statement

Conceptualization: Le Thi Ngoc Anh, To Gia Kien, Nguyen Van Tap; Methodology: Le Thi Ngoc Anh, To Gia Kien, Nguyen Van Tap, Tran Thi Anh Tuong; Formal analysis: Le Thi Ngoc Anh, Nguyen Van Tuan; Investigation: Le Thi Ngoc Anh, Phan Tan Dan; Writing-original draft: Le Thi Ngoc Anh; Writing - review & editing: Jaelim Cho, Juyeon Ko, To Gia Kien, Nguyen Van Tuan, Tran Thi Anh Tuong and Phan Tan Dan; Supervision: To Gia Kien, Nguyen Van Tap.

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Ethical Declaration

Study ethical approval was obtained from the Ethics Council of the University of Medicine and Pharmacy at Ho Chi Minh City (Decision No. 458/HDDD-DHYD; May 12, 2022).

Conflict of interest

The authors have no potential conflicts of interest to disclose.

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