Original Article

Eating Habits, Physical Activity Practice and Clinical Prognosis of Colorectal Cancer Patients with Overweight/obesity

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Abstract

Background and objectives: Obesity is a chronic metabolic disease associated with the development of several other diseases, including cancer. The present study aims to evaluate the eating habits, physical activity, and clinical profiles of colorectal cancer (CRC) patients with overweight/obesity.

Methods: A cross-sectional study was conducted with data collected from the medical records of patients diagnosed with CRC (n = 41) from June 2019 to June 2022. Additionally, a questionnaire (n = 35) was applied to gather information on eating habits and physical activity. The data were subdivided into two groups of CRC patients: eutrophic and overweight/obesity. The results were presented as frequency distribution in percentage (%), mean ± standard deviation, or median and interquartile range.

Results: All patients presented adenocarcinoma-type; most were in stages 3 and 4 and underwent surgery and chemotherapy. The overweight/obesity group showed a higher prevalence of metastasis, recurrence, and death compared to the eutrophic group. Ninety-six percent of patients demonstrated the need to reevaluate their eating habits, and the overweight/obesity group presented a significantly lower consumption of vegetables. Walking was the most commonly practiced physical activity both before and after diagnosis. However, both groups experienced a reduction in physical activity after CRC diagnosis, especially in the overweight/obesity group, in which both the frequency (*p* = 0.001) and duration of physical activity (*p* = 0.0005) significantly decreased.

Conclusions: Overweight/obese individuals are associated with a worse clinical profile, which can be associated with unhealthy habits, low consumption of vegetables, and low physical activity.

Introduction

Colorectal cancer (CRC) ranks as the second most common cancer with the highest incidence in both men and women worldwide; it represents more than 10% of the global cancer burden (http://gco.iarc.fr/today; https://www.who.int/health-topics/cancer). In Brazil, INCA data estimate 45,630 new cases of CRC each year from the 2023–2025.[1]

CRC is a multifactorial disease. The main risk factors are age

(≥50 years), overweight, obesity, sedentary lifestyle, and consumption of unhealthy foods, such as low consumption of fruits, vegetables, and dietary fibers, or high consumption of processed meats and red meats. Furthermore, an individual's genetics, exposure to ionizing radiation, family history, previous presence of bowel, ovarian, uterine, or breast cancer, smoking, and excessive alcohol consumption significantly contribute to the development of this type of tumor (http://gco.iarc.fr/today).[2,3]

Obesity is a multifactorial disease characterized by an excess of adipose tissue concerning lean mass.[4–6] Additionally, in individuals with obesity, insulin resistance, hyperinsulinemia, hyperglycemia, dyslipidemia, chronic low-grade inflammation and oxidative stress factors often occur[7–9] and contribute to carcinogenesis.[10–12]

Hyperinsulinemia can promote proliferation and inhibit apoptotic mechanisms in cancer cells.[13–15] Additionally, in chronic low-grade inflammation, unbalanced levels of cytokines with increased levels of proinflammatory adipokines and decreased levels of anti-inflammatory adipokines are observed,[5,15] which can contribute to tumor development.[16]

Maintaining healthy eating habits, with a balanced diet rich in fruits and vegetables and a low intake of processed foods, foods rich in carbohydrates and fats, and red meats, contributes to preventing the development of overweight and obesity as well as cancer.[15,17–19]

In 2018, in its latest project to update the evidence assessment (Diet, Nutrition, Physical Activity, and Cancer: A Global Perspective), IARC (http://gco.iarc.fr/today) concluded that several results corroborate that physical activity is directly associated with a decrease in the risk of CRC development.[20] In addition to regular physical activity, avoiding sitting for an extended period can protect against CRC.[21]

Physical activity increases intestinal motility and decreases gastrointestinal transit time, thus reducing mucosal exposure time to carcinogens.[3,22] The body's antitumor immune defenses are improved by physical exercise, which increases the number and activity of macrophages and lymphocytes.[23] Furthermore, repeated physical activity contributes to defense against free radicals.[22,24]

Given the context of increased obesity and the interrelationship between obesity and CRC, as well as the influence of eating habits and physical activity on obesity and tumors, the objective of the present study was to evaluate the eating habits, physical activity, and clinical profiles of CRC patients with overweight/obesity.

Materials and methods

Type of study, population, and place of study

This article is a cross-sectional study using a quantitative approach with convenience samples. The data were collected from participants diagnosed with CRC between June 2019 and June 2022 at the Sinop Cancer Center (CECANS) in Sinop, Mato Grosso (MT), Brazil.

The research participants were recruited from CECANS. CECANS has been selected for over 14 years as a treatment center for cancer patients and a reference in cancer treatment, addressing the demand of patients from Sinop and 32 other cities in the MT and southern Pará states. The CECANS has a specialized multidisciplinary team that offers clinical oncology, chemotherapy, and palliative care services.

The city of study, Sinop, is located in the north of MT state, has 196,067 inhabitants, and is classified as one of the four largest cities in MT (https://censo2022.ibge.gov.br/panorama/?utm_source=ibge&utm_medium=home&utm_campaign=portal).

All the collected data originated from patients assisted by private agreements and private health plans. Data were collected during weekly visits to CECANS through reading, analysis, and electronic recording in Excel spreadsheets. The identities of the participants evaluated in the research were kept confidential.

Given the declaration of the World Health Organization (WHO) on January 30, 2020, the outbreak of the disease caused by the coronavirus disease 2019 (COVID-19) was considered a Public Health Emergency, and sanitary measures were adopted.

The selection of CRC for the research is related to the increasing incidence of this type of neoplasia in Mato Grosso, similar to national and international indices.

Inclusion criteria

Patients diagnosed with CRC between June 2019 and June 2022 received treatment at CECANS in Sinop-MT, and were aged 18 years or older.

Exclusion criteria

Patients diagnosed with CRC due to metastasis from other types of cancer and patients with recurrence of other types of cancer in the years evaluated. These conditions were excluded to avoid the influence of other types of cancer on the results.

Data collection procedures

Data collection from medical records

The collection of clinical and epidemiological data was performed through the analysis of medical records provided by the oncologic health team. The following data were collected and analyzed: year of entry, age, gender, marital status, city and state of residence, naturalness, ethnicity, body weight, height, body mass index (BMI), smoking status, alcohol consumption, type of colorectal tumor diagnosed, type of treatment (chemotherapy, radiotherapy, surgery), antineoplastic drug used, tumor stage, presence of metastasis, clinical prognosis, presence of other diseases such as diabetes mellitus (DM) and systemic arterial hypertension (SAH), and other medicines used (e.g., adjuvant drugs and metformin).

The process of obtaining the free informed consent form (FICF)

During this stage, patients were informed about the research project, and the FICF was provided. If the patient expressed interest in participating, the signed FICF was obtained, and the questionnaire was applied.

Questionnaire application

A questionnaire with 20 questions from the Food Guide: how to have a healthy diet - Ministry of Health.[25] Question 17 was adapted by adding the type of physical activity performed (e.g., gym, walking, cycling), intensity (mild, moderate, intense), and duration (minutes/hours per day). Two additional questions were added to the original questionnaire: question 19 asked whether the patient has comorbidities (such as DM, dyslipidemia, or cardiovascular disease such as SAH), and question 20 asked whether the patient is taking metformin. This was necessary to achieve the objectives of the research.

All patients admitted to CECANS from June 2019 to June 2022 and met the inclusion criteria were invited to participate in the study and to answer the questionnaire.

Groups of patients

The data of CRC patients were divided into two groups:
- Eutrophic Group: CRC patients with a BMI ≥ 18.6 and ≤ 24.9 kg/m^2;
- Overweight/Obesity Group: CRC patients with a BMI ≥ 25.0 kg/m^2.

Risks and benefits

The risks associated with the application of the questionnaire included discomfort and shame, particularly when participants did not understand the questions about eating habits and physical activity. To minimize these problems, the researcher allowed the participants to express their doubts, pause the filling process, or stop answering the questions. Regarding the handling of medical records, potential risks included patient loss and possible damage. To avoid these problems, medical records were manipulated only at CECANS, and no materials, such as water, coffee, or other foods, were consumed locally.

As a benefit, the research participants contributed indirectly to the survey of data, aiding in a better understanding of the prevalence and influence of overweight and obesity, as well as the impact of eating habits and the practice of physical activities on the development of CRC. Participants also directly received guidance on healthy eating.

Data analysis

The data were tabulated and analyzed using descriptive analysis in the Microsoft® Excel® Software Spreadsheet (Office 365). The data are presented as the mean ± standard deviation (SD) or percentage (%). Statistical evaluation was performed using Student's *t test* (parametric test, unpaired), the Mann–Whitney test (nonparametric test, unpaired), or the Wilcoxon test (nonparametric test, paired) for the quantitative analysis of continuous variables. The chi-square test (χ^2) or Fisher test was used to analyze categorical variables. The analyses were carried out using the GraphPad Prism® 8 program. The minimum acceptable significance level was $p < 0.05$.

A 2 × 2 contingency table was constructed with data related to exposure: Eutrophic versus Overweight/Obesity and events (e.g. metastasis vs. no metastasis). The odds ratio (OR) and the 95% confidence interval (CI) were calculated.

Ethical aspects

The ethical aspects were considered following Resolution 466/12 of the Brazilian Ministry of Health, which outlines regulatory ethics standards for research involving human beings. The project was executed only after authorization was obtained from the Medical Ethics Committee of CECANS and approval from the Ethics Committee on Research with Human Beings under process number 4,392,751. All participants provided written informed consent in accordance with the Declaration of Helsinki.

Results

Epidemiological profile of CRC patients according to BMI range

The data were collected from 41 participants: 3 patients were diagnosed in 2019 (7.3%), 11 in 2020 (26.8%), 11 in 2021 (26.8%), and 16 in 2022 (39%).

Regarding the BMI range, it was observed that 13 CRC patients were eutrophic (31.7%), and 28 were overweight/obese (68.3%), demonstrating the high percentage of patients with CRC presenting a BMI ≥ 25 kg/m^2. Moreover, as expected, body weight and BMI were significantly higher in the overweight/obesity group compared to the eutrophic group ($p < 0.0001$ and $p < 0.0001$, respectively) (Table 1).

Furthermore, the findings indicated that the average age of the patients was 48 years, with the predominant age group being young adults aged between 25 and 44 years, comprising 43.9% of the patients. According to gender, the total number of men (n = 25, 61%) exceeded the number of women (n = 16, 39%). Regarding marital status, it was observed that most patients were married (90.2%), and the highest percentage (46.3%) were of Hispanic ethnicity. Furthermore, it was observed that the majority were Sinop residents (39%) (Table 1). No statistical difference was observed in these variables (Table 1).

Staging and therapeutic profile of CRC patients according to BMI range

All patients were diagnosed with the CRC adenocarcinoma type, with 17% classified as tumor stage 2, 51.2% as stage 3, and 31.7% as stage 4. Of patients, 66.7% had a family history of cancer, 53.8% in the eutrophic group, and 71.4% in the overweight/obesity group. The majority of patients affirmed that they do not consume alcohol and smoke. Most patients underwent combined surgery and chemotherapy (85.4%), received treatment with 5-fluorouracil and calcium folinate, and received adjuvant treatment with dexamethasone and ondansetron (Table 2). About 31.7% presented with metastasis, and 22% (n = 9) died (Table 3).

Considering the TNM classification, which serves to verify the depth (T), the number of lymph nodes affected (N), and the extent of distant metastasis (M), it was observed that, concerning the tumor stage, the majority of patients were in stage 3 (61.5% in the eutrophic group and 46.4% in the overweight/obesity group) (Table 2). The tumor stage was also evaluated by dividing patients into two subgroups: tumor stages 1 and 2 and tumor stages 3 and 4. The most significant difference in prevalence between the two groups was observed for tumor stages 3 and 4 (eutrophic, n = 11, 84.6%; overweight/obesity, n = 23, 82.1%; $p = 0.99$) (Table 2).

Among the most commonly used chemotherapy drugs (Table 2), 5-fluorouracil and calcium folinate were used by 100% of the patients in the eutrophic group, followed by oxaliplatin, which was used by 77% of the patients. In the overweight/obesity group, 5-fluorouracil and calcium folinate were used by 92.8% of the patients, followed by oxaliplatin (50%), bevacizumab (39.3%), irinotecan (35.7%), and cetuximab (14.2%). For adjuvant drugs, dexamethasone and ondansetron were used for both groups. There was no significant difference in any of the variables analyzed.

Clinical profile and prognosis of CRC patients according to BMI range

Regarding other comorbidities, Table 3 shows that one patient in each group was diagnosed with DM ($p = 0.54$). Regarding SAH, there were 4 (30.8%) patients in the eutrophic group and 7 (25%) patients in the overweight/obesity group ($p = 0.33$).

Regarding the presence of metastasis (Table 3), it was observed that the eutrophic group tended to have fewer patients with metastasis (n = 3, 23%) compared to the overweight/obesity group (n = 10, 35.7%); however, there was no statistical difference between the groups. In total, 31.7% of all included CRC patients had metastasis. Both groups presented an incidence of affected lymph nodes. Evaluating the incidence of recurrences (relapse) it was observed that overweight/obesity patients were more affected (n = 7, 25%)

Table 1. Distribution of patients with colorectal cancer according to the eutrophic and overweight/obesity groups, and according to the sociodemographic characteristics of patients in the years 2019–2022

Variable	Eutrophic	Overweight/Obesity	Total	*p*
n (%)	13 (31.7)	28 (68.3)	41 (100)	–
Body weight (mean ± SD)	65.5 ± 8.5	81.8 ± 15.1***	73.5 ± 16.6	<0.0001
BMI (median (IQ))$^\&$	23.1 (20.5–24.4)	28.0 (27.1–31.8)***	27.2 (24.4–29.9)	<0.0001
Age (mean ± SD)	48 ± 15.5	47.5 ± 11.7	48 ± 12.9	0.92
Age Group (years)	n (%)	n (%)	n (%)	
25 to 44	6 (46.1)	12 (42.8)	18 (43.9)	0.93
45 to 59	3 (23.0)	8 (28.6)	11 (26.8)	
60 to 100	4 (30.8)	8 (28.6)	12 (29.3)	
Gender$^\#$	n (%)	n (%)	n (%)	
Female	7 (53.8)	9 (32.1)	16 (39.0)	0.30
Male	6 (46.1)	19 (67.9)	25 (61.0)	
Marital status$^\#$	n (%)	n (%)	n (%)	
Married	13 (100)	24 (85.7)	37 (90.2)	0.29
Single	0 (0.0)	4 (14.3)	4 (9.8)	
Ethnicity	n (%)	n (%)	n (%)	
White	5 (38.4)	10 (35.7)	15 (36.6)	0.49
Brown	5 (38.4)	14 (50.0)	19 (46.3)	
Black	1 (7.7)	0 (0.0)	1 (2.4)	
Not informed	2 (15.4)	4 (14.3)	6 (14.6)	
City (origin)	n (%)	n (%)	n (%)	
Sinop	6 (46.1)	10 (35.7)	16 (39.0)	0.64
Smile	2 (15.4)	8 (28.6)	10 (24.4)	
Other	5 (38.5)	10 (35.7)	15 (36.6)	
Naturality by Region	n (%)	n (%)	n (%)	
South	5 (46.1)	21 (75.0)	27 (65.8)	0.19
Southeast	1 (7.7)	0 (0.0)	1 (2.4)	
Midwest	2 (15.4)	5 (17.8)	7 (17.1)	
North	2 (15.4)	1 (3.6)	3 (7.3)	
Northeast	1 (7.7)	0 (0.0)	1 (2.4)	
Not informed	1 (7.7)	1 (3.6)	2 (4.9)	
State (Citizenship)	n (%)	n (%)	n (%)	
Paraná	5 (38.4)	11 (39.6)	16 (39.0)	0.29
Rio Grande do Sul	1 (7.7)	7 (25.0)	8 (19.5)	
Santa Catarina	0 (0.0)	3 (10.7)	3 (7.3)	
Mato Grosso	1 (7.7)	0 (0.0)	1 (2.4)	
Other	5 (38.4)	6 (21.4)	11 (26.8)	
Not informed	1 (7.7)	1 (3.6)	2 (4.9)	

Groups: Eutrophic (BMI–18.6 to 24.9 kg/m^2) and Overweight/Obesity (BMI ≥ 25 kg/m^2). The results are expressed as mean ± standard deviation, median (interquartile ranges of 25% and 75%) or numbers of individuals and percentages (n (%)). Statistical analysis: Student's *t* test (unpaired), $^\&$Mann–Whitney test (unpaired), the chi-square test (χ^2), and the $^\#$Fisher test. BMI, body mass index.

Table 2. Distribution of patients with colorectal cancer according to the eutrophic and overweight/obesity groups, and according to the clinical characteristics of patients in the years 2019–2022

Variable	Eutrophic	Overweight/ Obesity	Total	p
n (%)	13 (31.7)	28 (68.3)	41 (100)	
Type of colorectal tumor#	n (%)	n (%)	n (%)	
Adenocarcinoma	13 (100)	28 (100)	41 (100)	0.99
Staging	n (%)	n (%)	n (%)	
2	2 (15.4)	5 (17.8)	7 (17.0)	0.87
3	8 (61.5)	13 (46.4)	21 (51.2)	
4	3 (23.0)	10 (35.7)	13 (31.7)	
Tumor Stage#	n (%)	n (%)	n (%)	
1 and 2	2 (15.4)	5 (17.9)	7 (31.7)	0.99
3 and 4	11 (84.6)	23 (82.1)	34 (68.3)	
Family History#	n (%)	n (%)	n (%)	
Yes	7 (53.8)	15 (71.4)	22 (66.7)	0.47
No	5 (41.7)	6 (28.6)	11 (33.3)	
Smoking#	n (%)	n (%)	n (%)	
Yes	1 (7.7)	6 (24.0)	7 (18.4)	0.39
No	12 (92.3)	19 (76.0)	31 (81.6)	
Alcoholism#	n (%)	n (%)	n (%)	
Yes	4 (33.3)	2 (8.3)	6 (16.7)	0.15
No	8 (66.7)	22 (91.7)	30 (83.3)	
Type of Treatment	n (%)	n (%)	n (%)	
Chemotherapy	1 (7.7)	1 (3.6)	2 (4.9)	0.32
Surgery + Chemotherapy	12 (92.3)	23 (82.1)	35 (85.4)	
Chemotherapy + Radio	_	4 (14.2)	4 (9.7)	
Chemotherapy Medicines	n (%)	n (%)	n (%)	
5-Fluorouracil	13 (100)	26 (92.8)	39 (95.1)	0.41
Calcium Folinate	13 (100)	26 (92.8)	39 (95.1)	
Irinotecan	2 (15.4)	10 (35.7)	12 (29.3)	
Cetuximab	_	4 (14.2)	4 (9.7)	
Bevacizumab	3 (23.0)	11 (39.3)	14 (34.1)	
Oxaliplatin	10 (77.0)	14 (50.0)	24 (58.5)	
Adjuvants	n (%)	n (%)	n (%)	
Dexamethasone	12 (92.3)	24 (85.7)	36 (87.8)	0.86
Ondansetron	13 (100)	27 (96.4)	40 (97.6)	
Folinic Acid	–	1 (3.6)	1 (2.4)	
Omeprazole	_	2 (7.1)	2 (4.9)	
Atropine	2 (15.4)	4 (14.2)	6 (14.6)	
Clor. diphenhydramine	3 (23.0)	10 (35.7)	13 (31.7)	

Groups: Eutrophic (BMI–18.6 to 24.9 kg/m2) and Overweight/Obesity (BMI ≥ 25 kg/m2). The results are expressed as the number of individuals and percentage (n (%)). Statistical analysis: chi-square test (χ^2) and #Fisher test. BMI, body mass index.

Table 3. Distribution of patients with colorectal cancer according to the eutrophic and overweight/obesity groups, and according to the prevalence of other comorbidities and the clinical prognosis

Variable	Eutrophic	Overweight/Obesity	Total	OR	p
n (%)	13 (31.7)	28 (68.3)	41 (100)		
Diabetes mellitus[#]	n (%)	n (%)	n (%)		
Yes	1 (7.7)	1 (3.6)	2 (4.9)	0.44	0.54
No	12 (92.3)	27 (96.4)	39 (95.1)	(0.02–9.1)	
HAS[#]	n (%)	n (%)	n (%)		
Yes	4 (30.8)	7 (25.0)	11 (26.8)	0.75	0.72
No	9 (69.2)	21 (75.0)	30 (73.2)	(0.20–2.76)	
Recurrence[#]	n (%)	n (%)	n (%)		
Yes	1 (7.7)	7 (25.0)	8 (19.5)	4.0	0.40
No	12 (92.3)	21 (75.0)	33 (80.5)	(0.53–48.4)	
Metastasis[#]	n (%)	n (%)	n (%)		
Yes	3 (23.0)	10 (35.7)	13 (31.7)	1.85	0.49
No	10 (77.0)	18 (64.3)	28 (68.3)	(0.40–7.32)	
Affected lymph nodes[#]	n (%)	n (%)	n (%)		
Yes	9 (69.2)	21 (75.0)	30 (75.2)	1.33	0.72
No	4 (30.8)	7 (25.0)	11 (26.8)	(0.36–5.00)	
Death[#]	n (%)	n (%)	n (%)		
Yes	1 (7.7)	8 (28.6)	9 (22.0)	4.8	0.23
No	12 (92.3)	20 (71.4)	32 (78.0)	(0.67–57.2)	

Groups: Eutrophic (BMI–18.6 to 24.9 kg/m2) and Overweight/Obesity (BMI ≥ 25 kg/m2). The results are expressed as the number of individuals and percentage (n (%)). Statistical analysis: [#]Fisher test and odds ratio (OR) analysis. BMI, body mass index.

compared to the eutrophic group (n = 1, 7.7%) (Table 3).

Deaths were recorded in both groups: 1 (7.7%) in the eutrophic group and 8 (28.6%) in the overweight/obesity group (Table 3). However, no statistical difference was observed among the groups (*p* = 0.23). The percentage of patients who died was higher in the overweight/obesity group than in the eutrophic group.

Eating habits of colorectal cancer patients

Based on the analysis of medical records (n = 41), 35 patients who underwent CRC treatment participated in the data collection through a questionnaire.

One of the guidelines of the National Food and Nutrition Policy is the promotion of healthy eating. The Food Guide, informed by the eating and cultural habits of Brazilians and supported by scientific evidence, aims to educate the population about their dietary habits based on the total points assigned in the questionnaire response. This sum should fit the score indicated for 1 of the three groups: (G-1) individuals who need to adopt healthy eating habits (≤28 points), (G-2) individuals who should pay attention to eating habits (29–42 points), and (G-3) individuals who have healthy habits (≥43 points).

According to the results of the questionnaire (n = 35), only one CRC patient (2.9%) had healthy eating habits, whereas 71.4% (n = 25) needed to pay attention to their eating habits, and 25.7% (n = 9) needed to adopt healthy eating habits. According to the questionnaire scores, in the eutrophic group, only one patient (7.7%) presented healthy habits (G-3), 8 (61.5%) patients should give more attention to eating habits (G-2), and 4 (30.8%) patients needed to

adopt healthy eating habits (G-1), while in the overweight/obesity group, 17 (77.3%) patients needed to devote more attention to eating habits (G-2), seven (22.7%) patients needed to reevaluate their eating habits (G-1), and no patient presented a health habit.

Table 4 shows that all respondents in the eutrophic group chose breakfast, while in the overweight/obesity group, 3 (13.6%) patients reported not eating breakfast and 86.4% had breakfast. In comparison, lunch (92.3% and 100%, respectively) and dinner (92.3% and 86.3%, respectively) had various responses. Regarding the other snack options during the day, there was a considerable variation in the number of patients.

The frequency distribution of daily meals among patients with CRC indicated that the majority of patients claimed to have eaten at least three meals a day, including breakfast, lunch, and dinner (Table 4). Finally, it was observed that there was no statistical difference in any variables analyzed.

Regarding water consumption (Table 4), only 38.4% of the eutrophics and 40.9% of the overweight/obesity patients reported consuming the recommended daily water intake (2 L or more). In the overweight/obesity group, 18.2% of patients reported ingesting 1 L or less of water per day. Concerning the consumption of alcoholic beverages, patients in both groups consumed alcohol daily, with beer the most consumed in both groups (Table 4).

For fruit consumption, there was no difference between the groups. In both groups, the majority of patients reported consuming fruits daily. In the eutrophic group, 23% reported not consuming fruits, 7.7% reported consuming only one fruit a day, 38.5% consumed two fruits a day, and 30.8% consumed three fruits per

Table 4. Distribution of patients with colorectal cancer according to the eutrophic and overweight/obesity groups, and according to daily meals and water and alcoholic beverages

Variable	Eutrophic	Overweight/Obesity	Total	*p*
n (%)	13 (37.1%)	22 (62.9%)	35 (100%)	
Breakfast#	n (%)	n (%)	n (%)	
Yes	13 (100)	19 (86.4)	35 (92.1)	0.28
No	–	3 (13.6)	3 (7.9)	
Morning snack#	n (%)	n (%)	n (%)	
Yes	6 (46.1)	7 (31.8)	13 (37.1)	0.48
No	7 (53.8)	15 (68.1)	22 (62.8)	
Lunch#	n (%)	n (%)	n (%)	
Yes	12 (92.3)	22 (100)	34 (97.1)	0.37
No	1 (7.7)	–	1 (2.9)	
Afternoon Snack#	n (%)	n (%)	n (%)	
Yes	7 (53.8)	11 (50.0)	18 (51.4)	0.99
No	6 (46.1)	11 (50.0)	17 (48.6)	
Dinner#	n (%)	n (%)	n (%)	
Yes	12 (92.3)	19 (86.3)	31 (88.6)	0.99
No	1 (7.7)	3 (13.6)	4 (11.4)	
Supper#	n (%)	n (%)	n (%)	
Yes	2 (15.4)	5 (22.7)	7 (20.0)	0.69
No	11 (84.6)	17 (77.3)	28 (80.0)	
Water (cups/day)$	n (%)	n (%)	n (%)	
<4	1 (7.7)	4 (18.2)	5 (14.3)	0.27
4 to 5	1 (7.7)	5 (22.7)	6 (17.1)	
6 to 8	6 (46.1)	4 (18.2)	10 (28.6)	
≥8	5 (38.4)	9 (40.9)	14 (40.0)	
Water (cups/day)&	8 (8–9)	8 (5–9)	8 (5–9)	0.23
Alcoholic beverage#	n (%)	n (%)	n (%)	
Yes	9 (69.2)	16 (72.7)	25 (71.4)	0.99
No	4 (30.8)	6 (27.3)	10 (28.6)	
Alcoholic beverage$	n (%)	n (%)	n (%)	
Does not consume	4 (30.8)	6 (27.3)	10 (28.6)	0.99
Occasionally	5 (38.4)	9 (40.9)	14 (40.0)	
Weekly	2 (15.4)	3 (13.6)	5 (14.3)	
Daily	2 (15.4)	4 (18.2)	6 (17.1)	
Type of Alcoholic Beverage$	n (%)	n (%)	n (%)	
Beer	9 (81.8)	15 (75.0)	24 (77.4)	0.69
Wine	1 (9.1)	4 (20.0)	5 (16.1)	
White lightning	1 (9.1)	1 (5.0)	2 (6.4)	

Groups: Eutrophic (BMI–18.6 to 24.9 kg/m^2) and Overweight/Obesity (BMI ≥ 25 kg/m^2). The results are expressed as the number of individuals and percentage (n (%)). Statistical analysis: &Mann–Whitney test, #Fisher test, and $Chi-square test. BMI, body mass index.

Table 5. Distribution of patients with colorectal cancer according to the eutrophic and overweight/obesity groups, and according to the frequency of fruit, vegetable, and grain consumption

Variable	Eutrophic	Overweight/Obesity	Total	p
n (%)	13 (37.1%)	22 (62.9%)	35 (100%)	
Fresh food				
Fruits#	n (%)	n (%)	n (%)	
Yes	10 (77.0)	19 (86.4)	29 (82.8)	0.65
No	3 (23.0)	3 (13.6)	6 (17.1)	
Fruits (unit/day)	n (%)	n (%)	n (%)	
0	3 (23.0)	3 (13.6)	6 (17.1)	0.66
1	1 (7.7)	4 (18.1)	5 (14.3)	
2	5 (38.5)	6 (27.2)	11 (31.4)	
3	4 (30.8)	9 (40.9)	13 (37.1)	
Fruits (unit/day)&	2 (0.5–3)	2 (1–3)	2 (1–3)	0.65
Vegetables#	n (%)	n (%)	n (%)	
Yes	13 (100)	19 (86.4)	32 (91.4)	0.28
No	0 (0.0)	3 (13.6)	3 (8.6)	
Amount of vegetables (tablespoons/day)	n (%)	n (%)	n (%)	
Does not consume	0 (0.0)	3 (13.6)	3 (8.6)	0.23
≤3	4 (30.8)	11 (50.0)	15 (42.8)	
4 to 5	4 (30.8)	4 (18.2)	8 (22.8)	
6 to 8	5 (38.5)	4 (18.2)	9 (25.7)	
Vegetables (tablespoons/day)&	5.0 (3.0–8.0)	3.0 (3.0–5.0)	3.0 (3.0–8.0)	0.04
Grain Consumption#	n (%)	n (%)	n (%)	
Yes	11 (84.6)	21 (95.4)	32 (91.4)	0.54
No	2 (15.4)	1 (4.5)	3 (8.6)	
Quantity of Grains	n (%)	n (%)	n (%)	
Non-consumption	2 (15.0)	1 (4.5)	3 (8.6)	0.64
<5 times a week	1 (7.7)	2 (9.0)	3 (8.6)	
1 tablespoon/day	2 (15.4)	2 (9.0)	4 (11.4)	
2 tablespoons/day	8 (61.5)	17 (77.3)	25 (71.4)	
Grain (tablespoons/day)&	2.0 (0.8–2.0)	2.0 (1.8–2.0)	2.0 (1.0–2.0)	0.34

Groups: Eutrophic (BMI–18.6 to 24.9 kg/m2) and Overweight/Obesity (BMI ≥ 25 kg/m2). The results are expressed as medians (interquartile ranges of 25% and 75%) or as numbers of individuals and percentages (n (%)). Statistical analysis: chi-square test (X2), #Fisher test, and &Mann–Whitney test. *p < 0.05 vs the Eutrophic group. BMI, body mass index.

day. In comparison, in the overweight/obesity group, 13.6% reported not consuming fruits, 18.1% confirmed consuming only one fruit daily, 27.2% affirmed consuming two fruits daily, and 40.9% reported consuming three fruits daily (Table 5).

Regarding the consumption of vegetables, both groups claimed to consume these foods. However, the number of vegetables consumed by the overweight/obesity group was significantly lower (3 (3–5)) when compared to the eutrophic group (5 (3–8)) ($p = 0.04$) (Table 5).

When analyzing the consumption of grains (beans, lentils, peas, chickpeas, seeds, or nuts), both groups reported consuming these foods frequently, with no statistical difference between them (Table 5).

There was no statistical difference between the groups regarding carbohydrate consumption (Table 6); 100% of the eutrophic patients and 95.5% of the overweight/obesity patients consumed carbohydrate-rich foods daily, such as rice, corn, and other cereals (including morning ones), cassava, yam, paste and other pasta, and sweet potato and baroa potato. Regarding the consumption of bread, 61.5% of the eutrophic patients reported consuming bread daily, while 81.8% of the CRC patients with overweight/obesity reported consuming bread every day (Table 6). Overall, 23% and 38.5% of the eutrophic patients reported consuming cake and simple biscuits, respectively, while 36.4% of the overweight/obese patients reported consuming simple cakes and cookies daily (Table 6).

Following the consumption of processed foods rich in carbohy-

Table 6. Distribution of patients with colorectal cancer according to the eutrophic and overweight/obesity groups, and the frequency of consumption of processed carbohydrates, fast foods, sweets, and sugary drinks

Variable	Eutrophic	Overweight/Obesity	Total	*p*
n (%)	13 (37.1%)	22 (62.9%)	35 (100%)	
Processed carbohydrates[#]				
Pasta[#]	n (%)	n (%)	n (%)	
Yes	13 (100)	21 (95.5)	34 (97.1)	0.99
No	0 (0.0)	1 (4.5)	1 (2.9)	
Pasta[&] (tablespoons)/day	4.0 (3.0–5.0)	3.5 (2.0–4.3)	4.0 (3.0–5.0)	0.05
Breads[#]	n (%)	n (%)	n (%)	
Yes	8 (61.5)	18 (81.8)	26 (74.3)	0.24
No	5 (38.5)	4 (18.2)	9 (25.7)	
Breads[&] (units or slice/day)	1.0 (0.0–2.0)	1.0 (1.0–2.0)	1.0 (0.0–2.0)	0.95
Simple Cake[#]	n (%)	n (%)	n (%)	
Yes	3 (23.0)	8 (36.4)	11 (31.4)	0.48
No	10 (77.0)	14 (63.6)	24 (68.5)	
Simple cakes[&] (slices/day)	0.0 (0.0–0.5)	0.0 (0.0–1.0)	0.0 (0.0–1.0)	0.53
Simple Biscuit[#]	n (%)	n (%)	n (%)	
Yes	5 (38.5)	8 (36.4)	13 (37.1)	0.99
No	8 (61.5)	14 (63.6)	22 (62.8)	
Simple biscuits[&] (units/day)	0.0 (0.0–3.0)	0.0 (0.0–2.0)	0.0 (0.0–2.0)	0.99
Fast Food and Builtins	n (%)	n (%)	n (%)	
Rarely	5 (38.5)	8 (36.4)	13 (37.1)	0.69
Daily	1 (7.7)	1 (4.5)	2 (5.7)	
1 time a week	4 (30.8)	4 (18.2)	8 (22.8)	
2–3 times a week	3 (23.0)	9 (40.9)	12 (34.3)	
Sweets and Sugary Drinks (/week)	n (%)	n (%)	n (%)	
Rarely	5 (38.5)	11 (50.0)	16 (45.7)	0.23
Daily	3 (23.0)	0 (0.0)	3 (8.6)	
1 time a week	2 (15.4)	4 (18.2)	6 (17.1)	
2–3 times a week	2 (15.4)	5 (22.7)	7 (20.0)	
4–5 times a week	1 (7.7)	2 (9.0)	3 (8.6)	

Groups: Eutrophic (BMI–18.6 to 24.9 kg/m2) and Overweight/Obesity (BMI ≥ 25 kg/m2). The results are expressed as median (interquartile ranges of 25% and 75%) or as numbers of individuals and percentages (n (%)). Statistical analysis: chi-square test (χ^2), [#]Fisher test, and [&]Mann–Whitney test. BMI, body mass index.

drates and fats, such as *fast food*/sausages, sweets/sugary drinks, and alcoholic beverages, both groups presented unhealthy food consumption patterns (Table 6).

A total of 38.5% of the eutrophic CRC patients and 36.4% of the overweight/obesity CRC patients stated that they did not consume or rarely consumed industrialized or processed foods (Table 6); however, the percentage of overweight/obese patients who claimed to eat these foods 2 to 3 times a week or 4 to 5 times a week was higher than that of the eutrophic group (Table 6).

According to Table 7, both groups regularly consumed meat. However, the percentage of CRC patients with overweight/obesity who consumed more protein (meat and eggs) was higher than that of the eutrophic group. Evaluating the consumption of animal pro-

teins, 100% of patients reported consuming meat (red and white) daily, while in the overweight/obesity group, one patient (4.5%) reported not consuming fish, and six patients (22.7%) reported consuming fish only occasionally throughout the year.

Table 7 shows that both groups had relatively lower consumption of milk and dairy compared to the consumption of other proteins (meat and fish). Furthermore, whole milk (an option rich in fats) was the most consumed by the patients, and more overweight/obese patients reported consuming whole milk daily.

Practice of physical activity of CRC patients according to BMI range

The physical activity data of patients before and after receiving

Table 7. Distribution of patients with colorectal cancer according to the eutrophic and overweight/obesity groups, and the frequency of animal protein (meat, fish, milk, and dairy products) consumption

Variable	Eutrophic	Overweight/Obesity	Total	*p*
N (%)	13 (37.1%)	22 (62.9%)	35 (100%)	
Meats#	n (%)	n (%)	n (%)	
Yes	13 (100)	22 (100)	35 (100)	0.99
No	0 (0.0)	0 (0.0)	0 (0.0)	
Daily amount of Meat	n (%)	n (%)	n (%)	
1 piece or 1 egg	3 (23.0)	4 (18.2)	7 (20.0)	0.88
2 pieces or 2 eggs	4 (30.8)	6 (27.3)	10 (21.6)	
>2 pieces or 2 eggs	6 (46.1)	12 (54.5)	18 (51.4)	
Meat (units/day)&	2.0 (1.5–3.0)	3.0 (2.0–3.0)	3.0 (2.0–3.0)	0.68
Usually take the apparent fat out of the meat?#	n (%)	n (%)	n (%)	
Yes	8 (61.5)	12 (54.5)	20 (57.1)	0.74
No	5 (38.5)	10 (45.5)	15 (42.8)	
Type of fat used	n (%)	n (%)	n (%)	
Animal lard or butter.	7 (53.8)	11 (50.0)	18 (51.4)	0.99
Vegetable oil such as soybean, corn or canola.	6 (46.1)	11 (50.0)	17 (48.6)	
Fish#	n (%)	n (%)	n (%)	
Yes	13 (100)	21 (95.5)	34 (97.1)	0.99
No	_	1 (4.5)	1 (2.9)	
Frequency consumed of Fish	n (%)	n (%)	n (%)	
A few times/year	2 (15.4)	6 (22.7)	8 (22.9)	
1 to 4 times/month	7 (53.8)	11 (50.0)	18 (51.4)	0.69
	4 (30.8)	5 (22.7)	9 (25.7)	
Milk and dairy products#	n (%)	n (%)	n (%)	
Yes	7 (53.8)	16 (72.7)	23 (65.7)	0.29
No	6 (46.1)	6 (27.3)	12 (34.3)	
Amount of Milk and dairy products (cups or pieces or slices/ day)	n (%)	n (%)	n (%)	
Non-consumption	6 (46.1)	6 (27.3)	12 (34.3)	0.52
1	4 (30.8)	9 (40.9)	13 (37.1)	
≥2	3 (23.0)	7 (31.8)	10 (28.6)	
Daily amount of Milk and dairy products (glasses or pieces/slices)&	1.0 (0.0–1.5)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	0.34
Type of Milk and derivatives	n (%)	n (%)	n (%)	
Whole	6 (46.1)	12 (54.5)	18 (51.4)	0.66
Semi-skimmed / Light	1 (7.7)	3 (13.6)	4 (11.4)	
Does not consume	6 (46.1)	7 (31.8)	13 (37.1)	

Groups: Eutrophic (BMI–18.6 to 24.9 kg/m^2) and Overweight/Obesity (BMI ≥ 25 kg/m^2). The results are expressed as median (IQ of 25% and 75%) or as numbers of individuals and percentages (n (%)). Statistical analysis: chi-square test (X^2), #Fisher test, and &Mann–Whitney test (unpaired). BMI, body mass index.

a diagnosis of CRC (Table 8) were analyzed, except for some patients in the overweight/obesity group who declared that they did not perform physical activity. The remaining interviewed patients participated in some form of physical activity. The number of physical activity practitioners decreased after diagnosis in both groups, with walking being the predominant activity.

Before diagnosis, the majority of patients in both groups (61.5% in the eutrophic group and 54.5% in the overweight/obesity group) performed some form of physical activity. Among the different activities, walking was the most common activity performed by the eutrophic group (n = 5, 38.5%), and the frequency of walking varied from 2 to 5 times a week, followed by bodybuilding prac-

Table 8. Distribution of the type and frequency of physical activity performed by patients with CRC before and after diagnosis

Variable	Eutrophic	Overweight/Obesity	Total	*p*
Before Diagnosis[#]				
Physical activity practice[#]	n (%)	n (%)	n (%)	
Yes	8 (61.5)	12 (54.5)	20 (57.1)	
No	5 (38.5)	10 (45.5)	15 (42.8)	0.74
Frequency				
No practice	5 (38.5)	10 (45.5)	15 (42.8)	0.60
2–3 times a week	3 (23.1)	7 (31.8)	10 (28.6)	
5–7 times a week	5 (38.5)	5 (22.7)	10 (28.6)	
Frequency (Times a week)[&]	3.0 (0.0–7.0)	2.0 (0.0–3.5)	2.0 (0.0–5.0)	0.39
Duration (min)[&]	30.0 (0.0–60.0)	30.0 (0.0–90.0)	0.0 (0.0–60.0)	0.68
Type of Physical Activity[#]				
Aerobic	Yes (1) No (12)	Yes (0) No (22)	–	0.37
Bodybuilding	Yes (2) No (11)	Yes (2) No (20)		0.62
Walking	Yes (5) No (8)	Yes (5) No (17)		0.44
Cycling	Yes (0) No (13)	Yes (1) No (21)		0.99
Swimming	Yes (0) No (13)	Yes (0) No (22)		0.99
Soccer	Yes (1) No (12)	Yes (4) No (18)		0.63
After Diagnosis[#]				
Physical activity practice[#]				
Yes	6 (46.1)	7 (31.8)	13 (37.1)	0.48
No	7 (53.8)	15 (68.2)	22 (62.9)	
Frequency				
No practice	7 (53.8)	15 (68.2)	22 (62.9)	0.69
2–3 times a week	4 (30.8)	5 (22.7)	9 (25.7)	
5–7 times a week	2 (15.4)	2 (9.0)	4 (11.4)	
Frequency (Times a week)[&]	0.0 (0.0–3.0)	0.0 (0.0–2.3)	0.0 (0.0–3.0)	0.31
Duration (min)[&]	0.0 (0.0–60.0)	0.0 (0.0–30.0)	0.0 (0.0–40.0)	0.34
Type of Physical Activity[#]				
Aerobic	Yes (1) No (12)	Yes (0) No (22)		0.37
Bodybuilding	Yes (1) No (12)	Yes (1) No (21)		0.99
Walking	Yes (4) No (9)	Yes (7) No (14)		0.99
Cycling	Yes (1) No (12)	Yes (0) No (22)		0.37
Swimming	Yes (0) No (13)	Yes (0) No (22)		0.99
Soccer	Yes (0) No (13)	Yes (0) No (22)		0.99
Paired analysis				
Eutrophic Group	Before Diagnosis	After Diagnosis		
Physical activity practice[#]	n (%)	n (%)		
Yes	8 (61.5)	6 (46.2)	–	0.70
No	5 (38.5)	7 (53.8)		

Table 8. *(continued)*

Variable	Eutrophic	Overweight/Obesity	Total	*p*
Frequency (Times a week)$^{\$\$}$	3.0 (0.0–7.0)	0.0 (0.0–3.0)	–	0.03
Duration (min)$^{\$\$}$	30.0 (0.0–60.0)	0.0 (0.0–60.0)	–	0.63
Overweight/Obese Group	Before Diagnosis	After Diagnosis		
Physical activity practice[#]				
Yes	12 (54.5)	7 (31.8)	–	0.22
No	10 (45.5)	15 (68.2)		
Frequency (Times a week)$^{\$\$}$	2.0 (0.0–3.5)	0.0 (0.0–2.25)[***]	–	0.001
Duration (min)$^{\$\$}$	30 (0.0–90.0)	0.0 (0.0–30.0)[***]	–	0.0005

Groups: Eutrophic (BMI–18.6 to 24.9 kg/m2) and Overweight/Obesity (BMI ≥ 25 kg/m2). The results are expressed as median (interquartile ranges of 25% and 75%) or as numbers of individuals and percentages (n (%)). Statistical analysis: [#]Fisher test, chi-square test; Mann–Whitney test; $^{\$\$}$Wilcoxon test (paired test). *$p < 0.05$ vs. Before diagnosis (Eutrophic) and ***$p < 0.001$ vs. Before diagnosis (Overweight/Obese group). BMI, body mass index; CRC, colorectal cancer.

tices (15.4%) and aerobic activity and soccer, each accounting for 7.7% (Table 8). In the overweight/obesity group, only five patients (22.7%) reported walking regularly, 9% practiced bodybuilding, 4.5% did cycling, and 18.2% played soccer (Table 8). Furthermore, the frequency of physical activity varied significantly in the overweight/obesity group, with 45.5% never performing it, 22.7% performing it 5 to 7 times a week, and 31.8% performing it 2 to 3 times a week (Table 8).

After the diagnosis of CRC, the profile of physical activity practices remained similar in both groups. In the eutrophic group, only six patients (46.1%) continued to perform physical exercise. Specifically, one patient started cycling, four performed walking, one practiced bodybuilding, and one performed aerobic activity. In the overweight/obesity group, there was a reduction in the number and percentage of patients who maintained regular physical activity habits, with only seven patients (31.8%) continuing the exercises (Table 6). There was no statistical difference between the groups before and after the diagnosis of CRC.

Upon evaluating the groups in isolation and comparing their physical activity practices before and after diagnosis (paired analysis), both groups experienced a decrease in the practice, frequency, and duration of physical activity after the diagnosis of CRC (Table 8). The frequency of physical activity in the eutrophic group significantly decreased after diagnosis ($p = 0.03$). In the overweight/obesity group, a statistically significant reduction was observed in the frequency ($p = 0.001$) and duration ($p = 0.0005$) of physical activity after diagnosis compared with the period before diagnosis (Table 8).

Discussion

According to the observed data, the majority of patients diagnosed with CRC were male. These data are in line with the literature, revealing a higher incidence of CRC in men than in women. It's noteworthy that females also present a high incidence rate and prevalence of the disease.[26–29] Alzahrani *et al.* (2021)[30] reaffirmed that men of all ages and nationalities have a 1.5 times higher risk of developing CRC than women. Bardou *et al.* (2013)[31] also demonstrated a higher prevalence (up to 70%) of CRC in males when associated with obesity.

BMI is used worldwide as an indicator of body weight and as an index to diagnose overweight and obesity, thereby assessing the risk of developing other diseases, such as CRC.[15,32–34] The present study observed that the majority of patients diagnosed with CRC had a BMI ≥ 25 kg/m^2 (68.3%).

According to Moghaddam *et al.* (2007),[35] increasing BMI values increase the risk of CRC development. The data indicate an increase of about 7% for every 2 kg/m^2 added to the individual's BMI and about 4% for every 2 cm increase in abdominal circumference.

Age is directly related to a higher incidence of CRC, and increasing age, along with factors such as obesity and a sedentary lifestyle, predisposes individuals to a high risk of developing CRC.[36,37] However, in the present study, the majority of patients were aged between 25 and 44 years (n = 18, 43.9%), revealing the involvement of the disease in the young adult age group. Similarly, recent studies have shown that the number of young adults diagnosed with CRC has increased considerably worldwide.[37–40]

Regarding tumor stage, the majority of patients were in stage 3 in the eutrophic group. In contrast, in the overweight/obesity group, 46.4% were in stage 3, and 35.7% were already in stage 4, demonstrating a poorer clinical prognosis. When the 5-year survival rate was stratified by tumor stage in patients diagnosed with CRC, the difference was very significant; specifically, for patients in stage 1, the survival rate was greater than 90%. However, at advanced stage 4, the survival rate decreases to 10%, highlighting that the stage is directly related to time and quality of life.[41]

It was observed that the eutrophic group had a lower incidence of patients with metastasis than the overweight/obese group. However, there was no statistical difference between the groups. Furthermore, 40% of all patients with CRC had metastasis, which represents a poor prognosis. Each year, more than one million Americans are diagnosed with cancer, and more than half of them ultimately die due to the metastatic spread of tumors during the disease progression.[30]

The incidence of recurrences was higher in patients with overweight/obesity than in patients with eutrophic. As mentioned above, the overweight/obesity group presented a higher prevalence of patients with CRC in stage 4 (35.7%), which may be related to increased metastasis and relapses in this group.

Deaths were recorded in both groups. Although no statistical difference was observed between the groups, the percentage of patients who died was higher in the overweight/obesity group, suggesting a possible association between obesity and unfavorable prognosis.

Both groups presented similar eating habits, and the majority needed to improve the quality of their eating, adopt healthier

habits, or pay more attention to the food consumed. Furthermore, individuals in the overweight/obesity groups consumed fewer vegetables daily.

A relationship between cancer protection and fruit and vegetable consumption lies in the fact that these foods are rich in bioactive substances, such as vitamins, minerals, fibers, carotenoids, flavonoids, steroids, and phenols, among other substances with preventive capacities.[42] Thus, it can be suggested that the decreased consumption of vegetables by patients in the overweight/obesity group contributes to the reduced prevention of CRC in these patients as well as the development of obesity.

There was no statistical difference between the groups concerning carbohydrate consumption (Table 6). However, the percentage of patients who reported consuming bread or simple cake was higher in the overweight/obese group (81.8% and 36.4%, respectively) than in the eutrophic group (61.5% and 23.0%, respectively). This suggested that the high carbohydrate consumption among most overweight/obese patients may contribute to both body weight gain and the development of CRC.

The majority of CRC patients with overweight/obesity reported consuming two or more pieces of meat per day. Additionally, several patients reported not consuming or rarely consuming fish, and a higher percentage reported ingesting whole milk. Thus, combined with their decreased consumption of vegetables, this dietary pattern may contribute to the development of CRC in these patients.

The consumption of industrialized foods rich in fats and preservatives is related to a potential risk of developing cancer. The consumption of white meat, especially fish, is a protective factor against CRC.[43–46]

Water plays important functions throughout the body and is essential for maintaining overall bodily functions.[47,48] Water intake is considered the most practical and efficient way to maintain adequate hydration of the body, helping to preserve physical and mental functions.[48] Although most patients with CRC ingest the recommended amount of water per day, 18.2% of overweight/obese patients ingest one liter or less of water daily.

Only one (4%) CRC patient presented healthy eating habits. Moreover, both groups should give more attention to their eating habits and improve the quality and type of foods consumed.

The Ministry of Health recommends adopting healthy eating habits combined with regular physical activity to improve quality of life and prevent various diseases.[25]

Data relating to the physical activity of patients before and after a diagnosis of CRC were analyzed, and only 57% of the CRC patients reported engaging in some physical activity before diagnosis. In addition, the number of physical activity practitioners decreased after diagnosis in both groups, with walking being the predominant activity.

The frequency and duration of physical activity varied significantly between the eutrophic and overweight/obesity groups and decreased significantly after diagnosis (Table 8, paired analysis). This significant reduction in physical activity, especially in the overweight/obesity group, suggested a more challenging clinical picture for these patients, making it difficult to maintain physical activity. Many patients are unable to remain active due to medical restrictions arising from the clinical picture itself, the development of the tumor, its stage, or treatment efficacy.

Even if not practiced frequently, physical activity is related to the individual's overall condition. In general, improving the prognosis and quality of life is extremely important in the prevention and treatment of cancer patients. Physical activity contributes to patients' emotional well-being, decreasing stress levels, anxiety and depression related to treatment.[49–53]

This study has several limitations. It requires patients, when they are answering the questionnaire, to recall their past habits and behaviors, referring to the moment before diagnosis, introducing potential bias such as recall bias, information bias, and classification bias. Furthermore, our cross-sectional study has a relatively small sample size (41 patients) because this research analyzed only patients who were admitted to CECANS from June 2019 to June 2022. CECANS cares for patients assisted by private agreements and private health plans. Thus, patients cared by public health plans were not included because the hospitals serving these patients were not available for research due to the COVID-19 pandemic.

Conclusions

In conclusion, this study revealed that a majority of patients diagnosed with CRC were male, overweight/obese, ~48 years old, Hispanic, married, and living in the city of Sinop-MT. All patients were diagnosed with adenocarcinoma type, with most presenting tumor stages 3 and 4. The overweight/obesity group presented higher percentages of metastasis and deaths, although no statistical difference was observed.

The majority of patients did not exhibit healthy eating habits and did not engage in physical activity regularly, which is essential to prevent tumor development. Both groups exhibited similar eating habits, with the majority indicating a need to improve their eating quality, adopt healthier habits, or pay more attention to consumption. Furthermore, the overweight/obesity group reported consuming fewer vegetables daily. Only 57% of patients reported practicing physical activity before their CRC diagnosis. Subsequently, after the diagnosis, both the frequency and duration of these activities decreased, and these variables were significantly different in the overweight/obesity group.

All these results highlight the important and urgent need to improve eating habits, encourage physical activity, and control body weight to prevent tumor development, especially in those with CRC. Such interventions hold the potential to improve the prognosis and quality of life of patients.

Conflict of interest

The authors have no conflict of interests related to this publication.

Author contributions

Contributed to study concept and design (PBFC, EAR, LDL, DAQ,

AR, ER, PA and EAIFQ), acquisition of the data (PBFC, EAR, LDL, DAQ, AR, ER, PA and EAIFQ), assay performance and data analysis (PBFC, EAR, LDL, KNSB, GSAA, CCO, DAQ, AR, ER, PA and EAIFQ), drafting of the manuscript (PBFC, DAQ, AR, ER, PA and EAIFQ), critical revision of the manuscript (PBFC, EAR, LDL, KNSB, GSAA, CCO, DAQ, AR, ER, PA and EAIFQ), supervision (PA and EAIFQ).

Ethical statement

The ethical aspects were considered following Resolution 466/12 of the Brazilian Ministry of Health, which stipulates regulatory ethics standards for research involving human beings. The project was executed only after authorization was obtained from the Medical Ethics Committee of the Sinop Cancer Center - (CECANS) and approval from the Ethics Committee on Research with Human Beings, under process number 4,392,751. All subjects provided written informed consent in accordance with the Declaration of Helsinki.

Data sharing statement

The data that support the findings of this study are available from the corresponding author upon request by email at eveline.queiroz@ufmt.br.

References

[1] Kerr J, Anderson C, Lippman SM. Physical activity, sedentary behaviour, diet, and cancer: an update and emerging new evidence. Lancet Oncol 2017;18(8):e457–e471. doi:10.1016/S1470-2045(17)30411-4, PMID:28759385.

[2] Hanselmann RG, Welter C. Origin of Cancer: Cell work is the Key to Understanding Cancer Initiation and Progression. Front Cell Dev Biol 2022;10:787995. doi:10.3389/fcell.2022.787995, PMID:35300431.

[3] Latino-Martel P, Cottet V, Druesne-Pecollo N, Pierre FH, Touillaud M, Touvier M, *et al*. Alcoholic beverages, obesity, physical activity and other nutritional factors, and cancer risk: A review of the evidence. Crit Rev Oncol Hematol 2016;99:308–323. doi:10.1016/J.CRITREVONC.2016.01.002, PMID:26811140.

[4] Fonseca EA, de Oliveira MA, Lobato Nde S, Akamine EH, Colquhoun A, de Carvalho MH, *et al*. Metformin reduces the stimulatory effect of obesity on in vivo Walker-256 tumor development and increases the area of tumor necrosis. Life Sci 2011;88(19-20):846–852. doi:10.1016/j.lfs.2011.03.005, PMID:21439974.

[5] Ray A. Cancer and comorbidity: The role of leptin in breast cancer and associated pathologies. World J Clin Cases 2018;6(12):483–492. doi:10.12998/WJCC.V6.I12.483, PMID:30397604.

[6] de Queiroz EA, Akamine EH, de Carvalho MH, Sampaio SC, Fortes ZB. Metformin reduces the Walker-256 tumor development in obese-MSG rats via AMPK and FOXO3a. Life Sci 2015;121:78–87. doi:10.1016/j.lfs.2014.11.028, PMID:25497710.

[7] Blüher M. Obesity: global epidemiology and pathogenesis. Nat Rev Endocrinol 2019;15(5):288–298. doi:10.1038/s41574-019-0176-8, PMID:30814686.

[8] Figueiredo AEB, Ceccon RF, Figueiredo JHC. Chronic non-communicable diseases and their implications in the life of dependente eldery people. Cien Saude Colet 2021;26(1):77–88. doi:10.1590/1413-81232020261.33882020, PMID:33533865.

[9] Silva AZ, Costa FPL, Souza IL, Ribeiro MC, Giordani MA, Queiroz DA, *et al*. Botryosphaeran reduces obesity, hepatic steatosis, dyslipidaemia, insulin resistance and glucose intolerance in diet-induced obese rats. Life Sci 2018;211:147–156. doi:10.1016/j.lfs.2018.09.027, PMID:30227131.

[10] Żelechowska P, Agier J, Kozłowska E, Brzezińska-Błaszczyk E. Mast cells participate in chronic low-grade inflammation within adipose tissue. Obes Rev 2018;19(5):686–697. doi:10.1111/OBR.12670, PMID:29334696.

[11] Bhardwaj P, Brown KA. Obese Adipose Tissue as a Driver of Breast Cancer Growth and Development: Update and Emerging Evidence. Front Oncol 2021;11:638918. doi:10.3389/FONC.2021.638918, PMID:33859943.

[12] Dietze EC, Chavez TA, Seewaldt VL. Obesity and Triple-Negative Breast Cancer: Disparities, Controversies, and Biology. Am J Pathol 2018;188(2):280–290. doi:10.1016/j.ajpath.2017.09.018, PMID:29128565.

[13] González Svatetz CA, Goday Arnó A. [Obesity and cancer: «Dangerous friendship»]. Med Clin (Barc) 2015;145(1):24–30. doi:10.1016/J.MEDCLI.2014.05.026, PMID:25023851.

[14] Kasprzak A. Insulin-Like Growth Factor 1 (IGF-1) Signaling in Glucose Metabolism in Colorectal Cancer. Int J Mol Sci 2021;22(12):6434. doi:10.3390/IJMS22126434, PMID:34208601.

[15] Queiroz EAIF, Carneiro PBF, Braz KN de S, *et al*. Obesity and cancer: mechanisms involved and therapeutic interventions. Sci Electron Arch 2022;15(3):30–56. doi:10.36560/15320221522.

[16] Dong Y, Zhou J, Zhu Y, Luo L, He T, Hu H, *et al*. Abdominal obesity and colorectal cancer risk: systematic review and meta-analysis of prospective studies. Biosci Rep 2017;37(6):BSR20170945. doi:10.1042/BSR20170945, PMID:29026008.

[17] Lauby-Secretan B, Scoccianti C, Loomis D, Grosse Y, Bianchini F, Straif K, *et al*. Body Fatness and Cancer–Viewpoint of the IARC Working Group. N Engl J Med 2016;375(8):794–798. doi:10.1056/NEJMSR1606602, PMID:27557308.

[18] Gu MJ, Huang QC, Bao CZ, Li YJ, Li XQ, Ye D, *et al*. Attributable causes of colorectal cancer in China. BMC Cancer 2018;18(1):38. doi:10.1186/S12885-017-3968-Z, PMID:29304763.

[19] Kamal N, Ilowefah MA, Hilles AR, Anua NA, Awin T, Alshwyeh HA, *et al*. Genesis and Mechanism of Some Cancer Types and an Overview on the Role of Diet and Nutrition in Cancer Prevention. Molecules 2022;27(6):1794. doi:10.3390/MOLECULES27061794, PMID:35335158.

[20] Sanchez NF, Stierman B, Saab S, Mahajan D, Yeung H, Francois F. Physical activity reduces risk for colon polyps in a multiethnic colorectal cancer screening population. BMC Res Notes 2012;5:312. doi:10.1186/1756-0500-5-312, PMID:22715975.

[21] Simons CC, Hughes LA, van Engeland M, Goldbohm RA, van den Brandt PA, Weijenberg MP. Physical activity, occupational sitting time, and colorectal cancer risk in the Netherlands cohort study. Am J Epidemiol 2013;177(6):514–530. doi:10.1093/AJE/KWS280, PMID:23420352.

[22] Olatunde A, Nigam M, Singh RK, Panwar AS, Lasisi A, Alhumaydhi FA, *et al*. Cancer and diabetes: the interlinking metabolic pathways and repurposing actions of antidiabetic drugs. Cancer Cell Int 2021;21(1):499. doi:10.1186/S12935-021-02202-5, PMID:34535145.

[23] Rezende LFM, Arnold M, Rabacow FM, Levy RB, Claro RM, Giovannucci E, *et al*. The increasing burden of cancer attributable to high body mass index in Brazil. Cancer Epidemiol 2018;54:63–70. doi:10.1016/J.CANEP.2018.03.006, PMID:29604601.

[24] Friedenreich CM, Orenstein MR. Physical activity and cancer prevention: etiologic evidence and biological mechanisms. J Nutr 2002;132(11 Suppl):3456S–3464S. doi:10.1093/JN/132.11.3456S, PMID:12421870.

[25] BRAZIL. FOOD GUIDE: HOW TO HAVE A HEALTHY DIET - MINISTRY OF HEATH. 1st edition. 2nd reimpression. Ministry of Health. Brasilia-DF. 2013.

[26] Lauby-Secretan B, Vilahur N, Bianchini F, Guha N, Straif K, International Agency for Research on Cancer Handbook Working Group. The IARC Perspective on Colorectal Cancer Screening. N Engl J Med 2018;378(18):1734–1740. doi:10.1056/NEJMSR1714643, PMID:29580179.

[27] Chan DS, Lau R, Aune D, Vieira R, Greenwood DC, Kampman E, *et al*. Red and processed meat and colorectal cancer risk: meta-analysis of prospective studies. PLoS One 2011;6(6):e20456. doi:10.1371/journal.pone.0020456, PMID:21674008.

[28] Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018;68(6):394–424. doi:10.3322/caac.21492, PMID:30207593.

[29] Salibasic M, Pusina S, Bicakcic E, Pasic A, Gavric I, Kulovic E, *et al*. Colorectal Cancer Surgical Treatment, our Experience. Med Arch 2019; 73(6):412–414. doi:10.5455/MEDARH.2019.73.412-414, PMID:3208 2011.

[30] Alzahrani SM, Al Doghaither HA, Al-Ghafari AB. General insight into cancer: An overview of colorectal cancer (Review). Mol Clin Oncol 2021;15(6):271. doi:10.3892/MCO.2021.2433, PMID:34790355.

[31] Bardou M, Barkun AN, Martel M. Obesity and colorectal cancer. Gut 2013;62(6):933–947. doi:10.1136/GUTJNL-2013-304701, PMID:2348 1261.

[32] Mandic M, Safizadeh F, Niedermaier T, Hoffmeister M, Brenner H. Association of Overweight, Obesity, and Recent Weight Loss With Colorectal Cancer Risk. JAMA Netw Open 2023;6(4):e239556. doi: 10.1001/jamanetworkopen.2023.9556, PMID:37083659.

[33] Jin X, Qiu T, Li L, Yu R, Chen X, Li C, *et al*. Pathophysiology of obesity and its associated diseases. Acta Pharm Sin B 2023;13(6):2403–2424. doi:10.1016/j.apsb.2023.01.012, PMID:37425065.

[34] Ma Y, Yang Y, Wang F, Zhang P, Shi C, Zou Y, *et al*. Obesity and risk of colorectal cancer: a systematic review of prospective studies. PLoS One 2013;8(1):e53916. doi:10.1371/JOURNAL.PONE.0053916, PMID:23349764.

[35] Moghaddam AA, Woodward M, Huxley R. Obesity and risk of colorectal cancer: a meta-analysis of 31 studies with 70,000 events. Cancer Epidemiol Biomarkers Prev 2007;16(12):2533–2547. doi:10.1158/ 1055-9965.EPI-07-0708, PMID:18086756.

[36] Mathers JC, Movahedi M, Macrae F, Mecklin JP, Moeslein G, Olschwang S, *et al*. Long-term effect of resistant starch on cancer risk in carriers of hereditary colorectal cancer: an analysis from the CAPP2 randomised controlled trial. Lancet Oncol 2012;13(12):1242–1249. doi:10.1016/S1470-2045(12)70475-8, PMID:23140761.

[37] Campos FGCM, Figueiredo MN, Monteiro M, Nahas SC, Cecconello I. Incidence of colorectal cancer in young patients. Rev Col Bras Cir 2017;44(2):208–215. doi:10.1590/0100-69912017002004, PMID:28658341.

[38] Petersson J, Bock D, Martling A, Smedby KE, Angenete E, Saraste D. Increasing incidence of colorectal cancer among the younger population in Sweden. BJS Open 2020;4(4):645–658. doi:10.1002/ BJS5.50279, PMID:32484318.

[39] Russo AG, Andreano A, Sartore-Bianchi A, Mauri G, Decarli A, Siena S. Increased incidence of colon cancer among individuals younger than 50 years: A 17 years analysis from the cancer registry of the municipality of Milan, Italy. Cancer Epidemiol 2019;60:134–140. doi:10.1016/J.CANEP.2019.03.015, PMID:31005829.

[40] Siegel RL, Miller KD, Jemal A. Cancer statistics, 2019. CA Cancer J Clin 2019;69(1):7–34. doi:10.3322/CAAC.21551, PMID:30620402.

[41] Li L, Jiang K, Li D, Li D, Fan Z, Dai G, *et al*. The Chemokine CXCL7 Is Related to Angiogenesis and Associated With Poor Prognosis in Colorectal Cancer Patients. Front Oncol 2021;11:754221. doi:10.3389/ FONC.2021.754221, PMID:34692540.

[42] Rock CL, Thomson C, Gansler T, Gapstur SM, McCullough ML, Patel AV, *et al*. American Cancer Society guideline for diet and physical activity for cancer prevention. CA Cancer J Clin 2020;70(4):245–271. doi:10.3322/caac.21591, PMID:32515498.

[43] de Brito DA, Maynard DDC. Evaluation of the relationship between nutrition and cancer: a view of the impact on nutritional status and quality of life of cancer patients. Nutr Clín Diet Hosp 2019;39(1):169–175. doi:10.12873/391aquino.

[44] Risérus U. Trans fatty acids and insulin resistance. Atheroscler Suppl 2006;7(2):37–39. doi:10.1016/J.ATHEROSCLEROSISSUP.2006.04.008, PMID:16713388.

[45] Chajès V, Thiébaut AC, Rotival M, Gauthier E, Maillard V, Boutron-Ruault MC, *et al*. Association between serum trans-monounsaturated fatty acids and breast cancer risk in the E3N-EPIC Study. Am J Epidemiol 2008;167(11):1312–1320. doi:10.1093/AJE/KWN069, PMID: 18390841.

[46] Vinikoor LC, Millikan RC, Satia JA, Schroeder JC, Martin CF, Ibrahim JG, *et al*. trans-Fatty acid consumption and its association with distal colorectal cancer in the North Carolina Colon Cancer Study II. Cancer Causes Control 2010;21(1):171–180. doi:10.1007/S10552-009-9447-3, PMID:19842051.

[47] Jéquier E, Constant F. Water as an essential nutrient: the physiological basis of hydration. Eur J Clin Nutr 2010;64(2):115–123. doi:10.1038/ EJCN.2009.111, PMID:19724292.

[48] Perales-García A, Ortega RM, Urrialde R, López-Sobaler AM. Physical activity and sedentary behavior impacts on dietary water intake and hydration status in Spanish schoolchildren: A cross-sectional study. PLoS One 2018;13(12):e0208748. doi:10.1371/JOURNAL. PONE.0208748, PMID:30596654.

[49] Inoue M, Yamamoto S, Kurahashi N, Iwasaki M, Sasazuki S, Tsugane S, *et al*. Daily total physical activity level and total cancer risk in men and women: results from a large-scale population-based cohort study in Japan. Am J Epidemiol 2008;168(4):391–403. doi:10.1093/ AJE/KWN146, PMID:18599492.

[50] Lugo D, Pulido AL, Mihos CG, Issa O, Cusnir M, Horvath SA, *et al*. The effects of physical activity on cancer prevention, treatment and prognosis: A review of the literature. Complement Ther Med 2019;44:9–13. doi:10.1016/J.CTIM.2019.03.013, PMID:31126580.

[51] Wolin KY, Yan Y, Colditz GA, Lee IM. Physical activity and colon cancer prevention: a meta-analysis. Br J Cancer 2009;100(4):611–616. doi:10.1038/SJ.BJC.6604917, PMID:19209175.

[52] Moore SC, Lee IM, Weiderpass E, Campbell PT, Sampson JN, Kitahara CM, *et al*. Association of Leisure-Time Physical Activity With Risk of 26 Types of Cancer in 1.44 Million Adults. JAMA Intern Med 2016;176(6):816–825. doi:10.1001/JAMAINTERNMED.2016.1548, PMID:27183032.

[53] Hidayat K, Zhou HJ, Shi BM. Influence of physical activity at a young age and lifetime physical activity on the risks of 3 obesity-related cancers: systematic review and meta-analysis of observational studies. Nutr Rev 2020;78(1):1–18. doi:10.1093/NUTRIT/NUZ024, PMID:31393566.