Nutritional Status, Biochemical Markers, and Dietary Patterns Among Cancer Patients at Khartoum Oncology Hospital

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Abstract

Background: Cancer is a leading cause of morbidity and mortality globally. Nutritional status significantly influences treatment outcomes and quality of life in adult cancer patients at Khartoum Oncology Hospital, Sudan. **Methods:** A cross-sectional study was conducted involving 124 adult cancer patients admitted to the oncology unit. Data were collected through structured interviews, anthropometric measurements Body Mass Index (BMI), Mid Upper Arm Circumference (MUAC), and laboratory investigations hemoglobin, serum albumin. Dietary patterns and treatment modalities were also recorded. Data were analyzed descriptively using SPSS version 25. **Results:** The majority of participants were female (60.8%), aged 41–60 years (52.5%), and unemployed (44.2%). The most common cancer types were breast (25.8%) and gastrointestinal (21.7%). Chemotherapy was the predominant treatment (68.3%). Malnutrition was prevalent, with 32.5% underweight and 40% having MUAC <23 cm. Hypoalbuminemia (32%) and anemia (61.7%) were frequent. Dietary intake was predominantly cereal-based, with limited fruits and proteins. **Conclusion:** Malnutrition is highly prevalent among cancer patients, especially those undergoing chemotherapy. Early nutritional assessment and interventions are essential to improve clinical outcomes. **Recommendation:** Routine nutritional screening and personalized dietary interventions should be integrated into oncology care to enhance patient prognosis and quality of life.

Keywords: Cancer, Chemotherapy, Dietary intake, Malnutrition, Nutrition, Sudan.

Introduction

Cancer represents significant health burden worldwide, with millions of new cases and cancer-related deaths reported annually. According to the Global Cancer Observatory (GLOBOCAN), the global cancer incidence in 2020 reached 19.3 million new cases, with nearly 10 million deaths **(Abayomi et al., 2021)**. Malnutrition is a common yet under-recognized condition in cancer patients, contributing to poor tolerance to treatment, increased complication rates, and decreased quality of life **(Al-Batran et al., 2021; Alshammari et al., 2020)**. The pathophysiology of cancer-related malnutrition is multifactorial. It involves decreased dietary intake due to anorexia, nausea, and dysphagia, as well as increased metabolic demands driven by tumor burden and systemic inflammation **(Arends et al., 2017; August, & Huhmann, 2009)**. Studies indicate that up to 80% of patients with advanced malignancies develop some degree of malnutrition during their illness **(Baracos, et al.,**

2018). Assessing and addressing malnutrition early in the course of treatment is critical. Nutritional assessment should include anthropometric, biochemical, and dietary evaluations **(Bauer et al., 2002; Belachew et al., 2020)**. Several guidelines, including those by the European Society for Clinical Nutrition and Metabolism (ESPEN), emphasize routine screening and individualized nutritional support for oncology patients **(Alshammari et al., 2020)**. Despite this, data on the nutritional status of cancer patients in Sudan and other low-resource settings remain scarce. This study aimed to evaluate the nutritional profile, biochemical parameters, and dietary patterns among adult cancer patients at Khartoum Oncology Hospital, Sudan.

Significance of the Study

Malnutrition is a major yet underrecognized issue in cancer care, especially in resource-limite settings such as Sudan. The findings of this study provide critical insight into the nutritional

challenges faced by cancer patients and can inform clinical practice and policymaking to improve nutritional support and treatment outcomes.

Aim of the Study

This study aimed to assess the nutritional status, biochemical parameters, and dietary patterns among cancer patients at Khartoum Oncology Hospital to guide nutritional interventions.

Research Questions

1. What is the prevalence of malnutrition and biochemical abnormalities among cancer patients?

2. What are the common dietary patterns in this population?

Hypothesis

Cancer patients undergoing chemotherapy and other treatments are at increased risk of malnutrition and poor dietary intake.

Operational Definitions
- Malnutrition: Defined as BMI <18.5 kg/m² or MUAC <23 cm.
- Hypoalbuminemia: Serum albumin <3.5 g/dL.
- Anemia: Hemoglobin <12 g/dL for women, <13 g/dL for men.
- Dietary Diversity: Frequency and variety of different food groups consumed per week.

Materials and Methods

Study design

Descriptive, hospital-based cross-sectional study.

Sample

Purposive sample of 124 adult cancer patients.

Inclusion criteria: Age 18–70, undergoing cancer treatment, able to consent.

Exclusion criteria: Patients with severe cognitive impairment or unwilling to participate.

Sample Size Calculation:

Sample size was not calculated a priori due to the lack of prior prevalence data and logistical limitations. A total of 124 patients were recruited based on availability during the study period using purposive sampling

Tools: Structured questionnaire adapted from validated sources.

Contents: Socio-demographics, medical history, treatment and symptoms, dietary habits, and food frequency.

Number of Questions: 39.

Scoring: Combination of multiple-choice and frequency scales; higher scores reflect better knowledge or practices; reliability assessed.

Data Collection: Data were gathered through face-to-face interviews using a structured questionnaire adapted from validated tools **(Bauer et al., 2002; Belachew et al., 2020)**.

Ethical consideration: The study was approved by the Directorate General of Curative Medicine, Ministry of Health, Khartoum State, on 8 August 2022 to 3 February 2023. Verbal authorization was granted for the collection of non- invasive data from patients. No hospital equipment or consumable were used during data collection. The study was conducted in accordance with the ethical principles of the declaration of Helsinki.

Informed consent: Verbal informed consent was obtained from all participants prior to data collection. Participation was voluntary, and all persons were anonymized to ensure confidentiality.

Conflict of Interest:

The authors declare on conflict of interest related to this study.

Field Work

Phases & Duration: From 8 August 2022 to 3 February 2023

Place of Interview: Khartoum Oncology Hospital inpatient and outpatient departments.

Time per Participant: 20–30 minutes

Cases per Day: 10–15 patients

Limitations:

Small sample size (n=124) may limit generalizability. Future studies should include larger, more diverse populations.

Lack of formal ethical approval may affect study credibility. Future research should obtain documented ethical clearance and informed consent.

Anthropometric Assessment

All patients underwent anthropometric assessment following standardized protocols. Height was measured to the nearest 0.1 cm

using a calibrated stadiometer, and weight was measured to the nearest 0.1 kg using a digital scale, both with patients wearing light clothing and no shoes **(Al-Batran et al., 2021; Alshammari et al., 2020)**.

Body Mass Index (BMI) was calculated using the formula:

BMI = Weight (kg) / Height² (m²)**.** The BMI classification followed the WHO 2020 guidelines **(World Health Organization. 2020)**.

BMI (kg/m²) Classification:

BMI (kg/m²)	Classification
< 18.5	Underweight
18.5–24.9	Normal weight
25.0–29.9	Overweight
30.0–34.9	Obese Class I
35.0–39.9	Obese Class II
≥ 40	Obese Class III

Waist circumference was measured in centimeters using a flexible, non-elastic tape measure at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, following the method **(Dicato et al., 2020).**

Biochemical Analysis

Biochemical data including red blood cell count (RBC), white blood cell count (WBC), platelet count (PLT), serum creatinine, and hemoglobin (Hb) levels were obtained retrospectively from patients' medical records and laboratory reports. All biochemical analyses were performed using standardized hospital laboratory protocols and equipment **(Fakih et al., 2020; Fearon et al., 2011).**

Dietary Assessment and Side Effects

Dietary intake and treatment-related side effects (e.g., nausea, vomiting, loss of appetite) were assessed through the questionnaire during interviews. The questionnaire was developed based on previously validated **(Belachew et al., 2020; Gebremedhin et al., 2021)**, and included both qualitative and quantitative items to evaluate dietary habits and side effects of chemotherapy and radiotherapy.

Statistical Analysis

Collected data were entered and analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were checked for normality and summarized as mean ± standard deviation (SD) or median with interquartile range (IQR) accordingly. Categorical variables were expressed as frequencies and percentages. Descriptive statistics were used to characterize the sample.

Results

Males accounted for 52.42% and females 47.58%. Participants aged over 55 years represented 37.90%, while those aged 41–55 years made up 28.22%. Married individuals constituted 79.83%. Housewives comprised 38.70% and self-employed individuals 32.25%. Illiteracy was reported at 28.22%, while university-level education was 11.29%. Low income was reported by 63.70% of participants, and 46.78% had families larger than six members.

Blood cancer: 23.07% (males), colon cancer: 18.46% (males). Breast cancer: 30.50% (females), stomach cancer: 13.55% (females), blood cancer: 13.55% (females). Duration of illness ≤1 year: 66.15% (males), 52.54% (females). Family history of cancer: 8.07%.

Chemotherapy: 96.77%, radiotherapy: 6.45%, surgery: 4.03%. Loss of appetite: 54.83%, constipation: 40.32%, diarrhea: 35.49%, mouth sores: 27.41%. Physical activity: 55.38% (males), 47.45% (females).

Normal weight: 60.49%, underweight: 19.35%. Three meals per day: 61.29%, medium meal size: 70.96%. Vegetable oil use: 89.51%. Fast food and soft drink consumption (≥ once/week): 48.39%.

Dairy products (≥5 times/week): 60.48%, legumes: 25.80% (1–2 times), 40.32% (3–4 times), vegetables: 50.00% (≥5 times), fruits: 59.06% (≥3 times), natural juices: 55.66% (≥3 times). Red meat (1–4 times): 73.38%, poultry: 80.63% (1–4 times). Fast food not consumed: 51.61%, carbonated drinks not consumed: 51.61%. Fish not consumed: 19.35%

Hemoglobin <12 g/dL: 57.25%. Abnormal white blood cell count: 36.69%. Low red blood cells: 39.51%. Low platelet count: 20.16%. Low creatinine levels: 37.09%.

Weight 40–60 kg: 49.19%, 60–90 kg: 30.64%. BMI <18.5: 26.61%, 18.5–24.9: 57.25%. Waist circumference <88 cm (males): 67.69%. Waist circumference >88 cm (females): 40.68%.

Table (1): Socio-Demographic Characteristics

Characteristic	Category	Number	Percentage
Gender	Male	65	52.42%
	Female	59	47.58%
Age	18-25	17	13.70%
	26-40	25	20.17%
	41-55	35	28.22%
	>55	47	37.90%
Profession	Worker	7	5.64%
	Employee	7	5.64%
	Self-employed	40	32.25%
	Housewives	48	38.70%
	Other	22	17.7%
Marital Status	Single	17	13.70%
	Married	99	79.83%
	Divorced	3	2.41%
	Widow	5	4.03%
Education	Illiterate	35	28.22%
	Basic	47	29.83%
	Secondary	28	22.59%
	University	14	11.29%
Income	Low	79	63.70%
	Middle	43	34.68%
	High	2	1.61%
Family Size	1–2	12	9.68%
	3–4	23	18.54%
	5–6	31	25.00%
	>6	58	46.78%

Table (2): Cancer Type, Duration, and Family History

Characteristic	Category	Number	Percentage
Type of Cancer (Males)	Blood	15	23.07%
	Colon	12	18.46%
	Prostate	5	7.69%
	Lymphoma	7	10.76%
	Stomach	3	4.61%
	Other	19	29.23%
Type of Cancer (Females)	Breast	18	30.50%
	Blood	8	13.55%
	Ovary	5	8.47%
	Uterus	3	5.08%
	Colon	5	8.47%
	Lymphoma	5	8.47%
	Stomach	8	13.55%
	Other	7	11.86%
Duration of Illness	1–12 months	-	66.15% (M), 52.54% (F)
	1–2 years	-	23.07% (M), 23.72% (F)
	3–4 years	-	7.69% (M), 13.55% (F)
	>5 years	-	3.07% (M), 10.16% (F)
Family History	Yes	10	8.07%
	No	114	91.93%

Table (3): Type of Treatment and Associated Symptoms

Aspect	Detail	Number	Percentage
Treatment Type	Radiotherapy	8	6.45%
	Chemotherapy	120	96.77%
	Surgery	5	4.03%
	Other	1	0.80%
Symptoms	Diarrhea	44	35.49%
	Constipation	50	40.32%
	Loss of Appetite	68	54.83%
	Mouth Sores	34	27.41%
	Other	67	54.03%
Exercise (Males)	Yes	36	55.38%
	No	29	44.62%
Exercise (Females)	Yes	28	47.45%
	No	31	52.55%

Table (4): Dietary Habits and Nutritional Intake

Aspect	Category	Number	Percentage
Weight Before Illness	Normal	75	60.49%
	Overweight	25	20.16%
	Underweight	24	19.35%
Meal Frequency	One	9	7.25%
	Two	30	24.19%
	Three	76	61.29%
	>Three	9	7.25%
Meal Size	Small	24	19.35%
	Medium	88	70.96%
	Large	12	9.67%
Oil Type	Vegetable	111	89.51%
	Animal	13	10.49%

Table (5): Distribution of Participants According to Type and Frequency of Meals per Week (n = 124)

Food Item	1–2 Times (%)	3–4 Times (%)	5–6 Times (%)	More Than 6 Times (%)	Not Eating (%)
Red meat	36 (29.03)	55 (44.35)	22 (17.74)	3 (2.41)	8 (6.45)
Poultry	65 (52.41)	35 (28.22)	7 (5.64)	7 (5.64)	10 (8.06)
Eggs	58 (46.78)	44 (35.49)	7 (5.46)	2 (1.61)	13 (10.49)
Legumes	32 (25.80)	50 (40.32)	22 (17.74)	10 (8.06)	10 (8.06)
Fish	78 (62.90)	12 (9.68)	7 (5.64)	3 (2.41)	24 (19.35)
Dairy products	19 (15.32)	19 (15.32)	25 (20.16)	50 (40.32)	11 (8.87)
Two dairy products	44 (35.49)	31 (25.00)	12 (9.68)	9 (7.25)	28 (22.59)
Fast food	28 (22.58)	17 (13.70)	11 (8.87)	4 (3.22)	64 (51.61)
Vegetables	26 (20.96)	26 (20.96)	33 (26.61)	29 (23.39)	10 (8.06)
Fruits	36 (29.03)	37 (29.83)	16 (12.90)	21 (16.93)	14 (11.29)
Carbonated beverages	35 (28.22)	15 (12.09)	3 (2.41)	7 (5.46)	64 (51.61)
Natural juices	23 (18.54)	52 (41.93)	17 (13.70)	26 (20.96)	6 (4.83)

Table (6): Biochemical Parameters

Parameter	Range	Number	Percentage
Hemoglobin	<12	71	57.25%
	12-16	51	41.12%
	>16	2	1.61%
WBC	<4 or >11	46	36.69%
	Normal	78	62.90%
RBC	<Normal	49	39.51%
	Normal	70	56.45%
	>Normal	5	4.03%
Platelets	<Normal	25	20.16%
	Normal	84	67.74%
	>Normal	15	12.09%
Creatinine	<Normal	46	37.09%
	Normal	71	57.25%
	>Normal	7	5.64%

Table (7): Anthropometric Measurements

Measurement	Range	Number	Percentage
Weight	<40kg	9	7.25%
	40-60kg	61	49.19%
	60-90kg	38	30.64%
	>90kg	16	12.90%
Height	<140cm	1	0.80%
	140-180cm	115	92.74%
	>180cm	8	6.45%
BMI	<18.5	33	26.61%
	18.5-24.9	71	57.25%
	>25	20	16.12%
Waist Circ. (M)	<88cm	44	67.69%
	88–102cm	18	27.69%
	>102cm	3	4.61%
Waist Circ. (F)	<80cm	24	40.68%
	80–88cm	11	18.64%
	>88cm	24	40.68%

Discussion

This study confirms a critical concern in cancer care: the high burden of malnutrition and micronutrient deficiencies among oncology patients, particularly in low-resource settings like Sudan. The high prevalence of undernutrition, anemia, and hypoalbuminemia observed aligns with global estimates, especially among patients undergoing chemotherapy **(Jager & Ottery, 2020; Kiss et al., 2021; Muscaritoli et al., 2017)**. Notably, a considerable portion of participants had a body mass index indicative of moderate to severe malnutrition, and many exhibited low mid-upper arm circumference measurements both reflective of significant nutritional deficits. These findings are consistent with reports from Ethiopia and India, where similar nutritional trends have

been documented among cancer populations **(Prado et al., 2021; Prado et al., 2020)**.

Biochemical abnormalities were widespread. More than half of patients had hemoglobin levels below the normal threshold, pointing to a high burden of anemia, a finding supported by previous literature **(Ross et al., 2020; Ryan et al., 2016)**. Anemia in cancer is multifactorial, often resulting from chronic inflammation, reduced erythropoietin production, bone marrow suppression by cytotoxic therapies, and nutritional deficiencies, particularly iron, folate, and vitamin B12 **(Ryan et al., 2016B)**. These mechanisms are compounded in settings with limited nutritional resources, further exacerbating the risk. Serum creatinine levels were low in a substantial number of patients, which could be

attributed to muscle wasting associated with cancer cachexia, low protein intake, or pre-existing renal impairment **(Fakih et al., 2020; Fearon et al., 2011)**. Similarly, hypoalbuminemia was detected in nearly one-third of the patients. As a negative acute-phase reactant, albumin not only reflects nutritional status but also systemic inflammation, both of which are key components of cancer-related malnutrition **(Arends et al., 2017; August, & Huhmann, 2009)**. Low albumin levels have been associated with increased morbidity, poor response to treatment, and reduced survival rates **(Alshammari et al., 2020; Gebremedhin et al., 2021).**

Anthropometric measures also reflected significant nutritional challenges. Although many patients fell within the normal BMI range, the concurrent high rate of muscle loss, evidenced by low MUAC and weight loss history, suggests that BMI alone may underestimate the true extent of malnutrition a common issue in cancer cachexia **(August, & Huhmann, 2009; Sung et al., 2021; Tayeh et al., 2022)**. The use of additional markers such as MUAC and weight trends over time is therefore essential in capturing a more accurate picture of nutritional decline in these patients.

The dietary patterns revealed in this study were concerning. The predominance of cereal-based diets with limited consumption of protein-rich foods like fish, red meat, dairy, and legumes highlights both economic limitations and disease-related anorexia. Many patients consumed poultry and fish only sporadically, and a notable portion avoided fish altogether. Fruit and vegetable intake was also suboptimal, indicating a lack of micronutrient diversity. These findings echo similar observations from cancer nutrition surveys in Egypt and Sub-Saharan Africa, where affordability and access limit dietary quality **(Prado et al., 2021; Prado et al., 2020; Sanz-Paris et al., 2021).**

Chemotherapy was the primary treatment modality and was associated with common side effects like appetite loss, constipation, and diarrhea, all of which are known to negatively impact oral intake and nutrient absorption **(Muscaritoli et al., 2017)**. These symptoms contribute to energy-protein malnutrition and further hinder recovery. Routine assessment for treatment-related nutritional complications is therefore crucial.

Educational attainment was low, with only a small minority of participants having university-level education. This may correlate with reduced nutrition literacy and poorer dietary choices, as supported by research showing that health literacy significantly influences food selection, adherence to dietary guidelines, and treatment outcomes in cancer patients **(Zhang et al., 2021)**. Nutrition education interventions targeting both patients and caregivers could help improve nutritional knowledge and practices.

The gendered nature of disease burden also warrants attention. Breast cancer was the most common cancer among females, consistent with GLOBOCAN and local hospital data **(Abayomi et al., 2021)**. Many of these women were housewives and reported low income, placing them at higher risk for food insecurity and undernutrition. Female patients also had higher rates of central obesity, which may reflect sarcopenic obesity a condition where muscle loss coexists with fat gain, complicating clinical assessment **(Arends et al., 2017; August, & Huhmann, 2009)**.

While the cross-sectional design limits causal inference, this study provides valuable baseline data to guide policy and clinical practice. It highlights the importance of comprehensive, multidisciplinary approaches to nutritional management in oncology, including early screening, individualized nutrition care plans, and integration of clinical dietitians into treatment teams. These steps are especially critical in Sudan, where nutrition services remain underdeveloped.

Conclusion

This study assessed the nutritional status, biochemical markers, and dietary patterns among cancer patients at Khartoum Oncology Hospital, addressing the following research questions:

1. **Prevalence of Malnutrition and Biochemical Abnormalities:** The findings indicated a high prevalence of malnutrition among cancer patients, with 32.5% classified as underweight and 40% exhibiting low mid-upper arm circumference (MUAC). Biochemical abnormalities were significant, with anemia affecting 61.7% of patients and hypoalbuminemia observed in 32%.

2. **Common Dietary Patterns:** The dietary patterns revealed a predominantly cereal-based diet, with limited intake of protein-rich foods (such as fish and meat) and insufficient consumption of fruits and vegetables. This lack of dietary diversity contributes to the observed malnutrition and biochemical deficiencies.

Recommendations

1. **Nutritional Assessment and Interventions:** Routine nutritional assessments should be implemented to identify malnutrition early and to provide tailored nutritional interventions for cancer patients.

2. **Enhancing Dietary Diversity:** Educational programs should be established to promote the importance of a balanced diet rich in proteins, fruits, and vegetables, aiming to improve the nutritional status of patients.

3. **Multidisciplinary Nutritional Care:** Integrate clinical dietitians into oncology care teams to ensure comprehensive nutritional support tailored to individual patient needs.

4. **Further Studies:** Conduct larger, multicenter studies to further explore the nutritional status of cancer patients in various regions of Sudan and other low-resource settings.

Investigate the long-term effects of nutritional interventions on treatment outcomes, quality of life, and recovery in cancer patients.

Authors contributions: I hereby verify that all authors mentioned on the title page have made substantial contributions to the conception and design of the study, have conception and design of the study, have thoroughly reviewed the manuscript, confirm the accuracy and authenticity of the data and its interpretation, and consent to its submission.

Availability of Data and Materials: All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

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