Changes in Weight and Body Composition among Patients Undergoing Neoadjuvant Chemotherapy

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Abstract

Cancer and its treatment affect the patient's nutritional status. Weight loss and changes in body composition following chemotherapy may affect clinical outcomes. In this prospective study, 139 cancer patients were included. Anthropometric measurements were performed using standardized equipment. Bioelectrical impedance analysis was used to assess body composition. Clinical data were obtained from the hospital database. Regardless of cancer type and stage, body mass index (BMI) and fat-free mass values decreased significantly four weeks after receiving neoadjuvant chemotherapy (NAC), while fat mass and body fat percentage increased significantly. The proportion of patients with low BMI, reduced muscle mass, and sarcopenic obesity also significantly increased (9.4% vs. 11.5%, 16.7% vs. 33.3%, and 5.0% vs. 21.7%, respectively). Approximately, 62% of patients experienced weight loss. Men were significantly more likely than women to have reduced muscle mass. Non-overweight patients had higher odds of losing weight and muscle mass than their overweight-obese counterparts. Similarly, colorectal cancer patients were 2.14 times more likely to experience moderate/severe weight loss than other patients. However, women with breast or uterine cancer were less likely to have reduced muscle mass than patients with other cancer types. Weight loss, reduced muscle mass, and sarcopenic obesity were common in our study population. Our findings suggest that NAC may increase the risk of malnutrition and that early nutritional interventions are required to prevent weight loss and body composition changes in cancer patients.

Keywords: *Body composition, Body mass index, Body weight, Cancer, Chemotherapy*

Introduction

Malnutrition is very common in cancer patients and has a negative impact on clinical outcomes. It is closely associated with a lower quality of life, an increased risk of morbidity and mortality, and a decreased responsiveness and tolerance to cancer treatment.[1, 2]

According to the Global Leadership Initiative on Malnutrition (GLIM), malnutrition is defined by three phenotypical criteria (weight loss, low body mass index (BMI), and reduced muscle mass) and two etiological criteria (reduced food intake or absorption, and increased disease burden or inflammation). To diagnose malnutrition using the GLIM criteria, experts recommend combining at least one phenotypic and one etiological criterion.[3]

Malnutrition affects 20-80% of oncology patients, particularly those with gastrointestinal, head, and neck cancers.[2] It is more common at the end of treatment than at the time of diagnosis.[4] Malnourished cancer patients are more likely to experience major health problems such as impaired immune function, reduced muscle function, decreased physical performance, increased toxicity, and delayed recovery from treatment.[1] Cancer-related malnutrition, on the other hand, remains largely unrecognized, underestimated, and undertreated in clinical practice worldwide.[2]

Depending on the tumor's type, location, stage, and treatment, cancer patients may experience different degrees of malnutrition.[2] The systemic effect of tumors and treatment-related side effects can cause a decrease in food intake, a change in energy expenditure, inflammation, and metabolic disorders.[5, 6] Such effects may also lead to increased gluconeogenesis from lactate, alanine, and glycerol in the liver to meet the cancer host's needs, as well as accelerated rates of proteolysis and lipolysis to maintain a high level of glucose synthesis. As a result,

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cancer patients are more likely to lose lean body mass and body fat due to decreased uptake and use of glucose and increased insulin resistance in adipose tissue, skeletal muscle, and liver.[7]

Chemotherapy is widely used in cancer treatment and can cause specific metabolic and nutritional changes as a result of treatment-induced toxicities and adverse effects such as nausea, vomiting, diarrhea, loss of appetite, and involuntary weight loss, all of which can significantly compromise treatment and clinical prognosis.[6] Previous research has found that BMI and percentage weight loss do not provide accurate information about nutritional status and loss of fat and non-fat mass.[8] Weight loss may include both lean and fat mass, and may be mediated by inflammation, which varies between cancer patients.[9] Furthermore, the relationships between BMI, lean body mass, and fat mass are not linear,[8, 10] and sarcopenia can occur and lead to poor outcomes even in obese patients.[11] Even though bioelectrical impedance analysis may produce errors in estimating fat-free mass, the lean body mass index has been proposed as a surrogate measure of muscle mass decline.[3]

Changes in body weight or body composition have clinical implications, as increased weight or fat mass and decreased lean mass were found to be associated with a greater risk of cancer recurrence and mortality[8, 11] and toxicity-induced treatment.[12] However, the independent prognostic values of weight loss and body composition measurements in cancer patients undergoing neoadjuvant chemotherapy remain not well explored, particularly in developing countries.

Thus, the purpose of this study was to investigate changes in weight and body composition among cancer patients during the first cycle of neoadjuvant chemotherapy and see how they related to gender, age, weight status, body fat level, tumor location, and time since cancer diagnosis.

Materials and Methods

Study design and patients

This is an observational study carried out at the Sidi Mohamed Ben Abdellah National Institute of Oncology (NIO) in Rabat, Morocco, from April to July 2022. Cancer patients who attended the NIO's day hospital for neoadjuvant chemotherapy were invited to take part in the study.

The sample size was determined using the manual for sample size determination in health studies. Based on the reported prevalence of cancer-related malnutrition that ranges from 20% to 80%,[2] we assumed that at least 50% of the study sample may experience weight loss and change in body composition, as indicators of nutritional status, after receiving NAC (the anticipated population proportion: P=0.50). With a 95% confidence interval and an absolute precision of 10 percentage points (d=0.10), the minimum sample size required for this study is 96 patients.[13] We anticipated a drop-out rate of around 50% after the second course of NAC and so the final sample size was N = 139.

The study protocol followed the ethical principles of the World Medical Association Declaration of Helsinki and was approved by the Biomedical Research Ethics Committee of the Faculty of Medicine and Pharmacy in Rabat (Certificate number: 99/22). Prior to data collection, all invited participants were informed about the research objectives and methods, and each patient involved in the study provided a written consent. The exclusion criteria included having previously received chemotherapy, having reported edema or amputation, and having metastatic cancer.

Data collection

Data was collected at two points: during the admission for the first cycle of neoadjuvant chemotherapy and four weeks later (before the second course of chemotherapy). The hospital database was used to obtain demographic and clinical information for all patients.

Anthropometric measurements were taken using standardized procedures and equipment. Body weight was obtained from a Seca digital scale with a capacity of 150 kg and an accuracy of 100 g, and height was measured using an adult portable stadiometer with a capacity of 200 cm and an accuracy of 1 mm.[14] BMI was calculated by dividing weight by height squared (kg/m^2). Using the WHO criteria, patients were classified as underweight (BMI < 18.5 kg/m^2), normal weight (18.5 kg/m^2 ≤ BMI <25.0 kg/m^2), overweight (25.0 kg/m^2 ≤ BMI < 30.0 kg/m^2), and obese (BMI ≥ 30.0 kg/m^2).[15]

Body composition was assessed by bioelectric impedance analysis (BIA) using a multifrequency impedance analyzer (Nutriguard-MS; Germany) and standardized techniques.[16] The measurements were taken for patients in a lying position using four self-adhesive electrodes placed on the dorsum surfaces of the right hand and foot, as directed by the manufacturer. According to previous studies assessing body composition in cancer patients using BIA,[17] Geneva's equation was used to estimate fat-free mass (FFM) based on the resistance (R50) and reactance (Xc50) measured at 50 kHz:[18]

$$FFM\ (Kg) = -4.104 + (0.518 \times (height\ (cm))^2 / R_{50kHz}) + (0.231 \times weight\ (kg)) + (0.130 \times Xc_{50kHz}) + (4.229 \times sex\ [men = 1, women = 0]) \quad (1)$$

Fat mass (FM), body fat percentage (BF%), and fat-free mass index (FFMI) were determined using the following formulas:

$$FM\ (Kg) = Weight\ (Kg) - FFM\ (Kg) \quad (2)$$

$$BF\% = (FM / Weight) \times 100 \quad (3)$$

$$FFMI = FFM/Height^2 \quad (4)$$

Excess body fat levels were defined based on BF% according to age and gender (20-39 years: > 19% and > 32%; 40-59 years: > 21% and > 33%; 60-79 years: >24% and > 35% for men and women, respectively).[19]

The GLIM criteria were used to assess malnutrition: i) low BMI: < 20 kg/m^2 if <70 years, or <22 kg/m^2 if >70 years; ii) weight loss within the past 6 months (moderate malnutrition: >5%; severe malnutrition: >10%; iii) low muscle mass or low FFM: < 17 kg/m^2 for men and <15 kg/m^2 for women.[3]

Individuals who had both excess body fat [19] and low muscle mass [3] were classified as having sarcopenic obesity.

Statistical analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS), version 22.0. The Kolmogorov-Smirnov test was used to determine the normality of variable distribution. Using descriptive statistics, results are presented as mean (± standard deviation (SD)) for continuous variables and as proportion for categorical variables. The Student's t-test (or Wilcoxon-signed rank test) and the Chi-square test were used to compare continuous and categorical variables, respectively. Bivariable and multivariable analyses using logistic regression models were conducted to assess the association of weight loss and low muscle mass with sex, age, weight status, body fat level, tumor localization, and time since cancer diagnosis. *P*-values less than 0.05 were considered statistically significant.

Results and Discussion

A total of 139 cancer patients were included in this observational study. The baseline characteristics of the study population are shown in **Table 1**. The patients' average age was 52.6 ± 12.1 years. Approximately 3.0 % of patients were classified as underweight, 39.6 % as normal weight, 30.2 % as overweight, and 27.3 % as obese. Women were more likely than men to be overweight, obese, or have excess body fat. More than two-thirds of patients (66.9 %) were diagnosed with breast cancer, with the remainder being diagnosed with cancer elsewhere, such as the colon and rectum (7.9 %), uterus (7.2 %), and stomach (3.6 %). The time since cancer diagnosis was < 1 year for 49 patients (35.3 %), 1-2 years for 75 patients (54.0 %), and > 2 years for 15 patients (10.8 %).

Table 1. Baseline characteristics of the study population

	All (N = 139)	Men (n = 21)	Women (n = 118)	*P*-value *
	Mean ± SD or %(95%CI)	Mean ± SD or %(95%CI)	Mean ± SD or %(95%CI)	
Age (years)	52.62±12.08	60.14±13.74	51.11±10.97	0.001
Anthropometric measures				
Body weight (Kg)	69.94±12.33	65.86±8.35	70.62±12.51	0.026
Height (m)	1.62±0.07	1.71±0.06	1.59±0.06	0.045
BMI (Kg/m^2)	26.72±5.23	22.01±2.78	27.67±5.10	0.000
Weight status				
Underweight	2.9(0.7-5.8)	14.3(0.0-28.6)	0.8(0.0-2.5)	0.000
Normal weight	39.6(31.7-47.5)	71.4(52.4-90.5)	33.9(26.3-42.4)	
Overweight	30.2(23.0-38.1)	14.3(0.0-28.6)	33.1(24.6-41.5)	
Obese	27.3(20.1-34.5)	-	32.2(24.6-40.7)	
Tumor localization				
Breast	66.9(59.0-74.8)	-	78.8(71.2-86.4)	0.000
Colorectal	7.9(3.6-12.2)	14.3(0.0-33.3)	6.8(2.5-11.8)	
Uterus	7.2(2.9-11.5)	-	8.5(3.4-13.6)	
Stomach	3.6(0.7-7.2)	9.5(0.00-23.8)	2.5(0.0-5.9)	
Lung	3.6(0.7-7.2)	23.8(9.5-42.9)	-	
Others[a]	10.8(5.8-16.5)	52.4(33.3-76.1)	3.4(0.8-6.8)	
Time since onset of disease				
< 1 yr	35.3(27.4-43.9)	42.9(23.8-66.7)	33.9(25.4-43.2)	0.000
1-2 yrs	54.0(45.3-61.9)	47.6(23.8-66.7)	55.1(45.8-63.6)	
> 2 yrs	10.8(5.8-15.8)	9.5(0.0-23.8)	11.0(5.9-16.9)	
Body composition data				
FFM (Kg)	45.56±5.45	49.99±6.11	44.83±4.91	0.010
FFM%	66.69±8.19	81.06±5.13	64.47±6.04	0.000
FFMI (Kg/m^2)	17.33±1.66	16.55±1.22	17.45±1.69	0.094
FM (Kg)	23.56±8.48	11.84±3.83	25.47±7.46	0.000
BF%	33.19±8.22	18.93±5.13	35.52±6.04	0.000
FMI (Kg/m^2)	9.13±3.47	3.94±1.35	9.93±2.94	0.000

Body fat levels				
Not excessive	35(23.3-48.3)	62.5(25.0-87.5)	30.8(19.2-44.2)	0.090
Excessive	65(51.7-76.7)	37.5(12.5-75.0)	69.2(55.8-80.8)	

Data are presented as mean ± standard deviation (SD) for continuous variables and proportion (95% confidence interval) based on 1000 bootstrap samples for categorical variables. BMI: Body mass index; FFM: Fat-free mass; FFM%: Fat-free mass percentage; FFMI: Fat-free mass index; FM: Fat mass; BF%: Body fat percentage; FMI: Fat mass index.
* *P* value of sex effect using the Student's t-test and the chi-square test to compare means and proportions, respectively.
[a] Other locations include the bladder (n=4), pancreas (n=2), prostate (n=2), kidney (n=2), gallbladder (n=1), intestine (n=1), lymphnode (n=1), tongue (n=1).
[b] Excess body fat levels: 20–39 years:>19 % and >32%; 40–59 years:>21% and >33%; 60–79 years:>24 % and >35% for men and women, respectively.[20]

Table 2 shows changes in body weight and body composition measurements from the start of neoadjuvant chemotherapy to four weeks later. While there was a significant increase in FM, BF%, and FMI, there was a significant decrease in weight, BMI, FFM, FFM%, and FFMI (P < 0.001).

Table 2. Changes in weight, BMI, and body composition parameters in patients during the first cycle of neoadjuvant chemotherapy

	Mean (SD)	Range	*P*-value *
Weight (Kg)			
Baseline	69.94 (12.35)	47 to 106	0.002
Post-treatment	68.65 (13.35)	39 to 114	
Changes (%)	-1.99 (6.7)	-24.2 to 15.1	
BMI (Kg/m^2)			
Baseline	26.72 (5.23)	17.85 to 44.26	0.001
Post-treatment	26.23 (5.57)	14.87 to 46.25	
Changes (%)	-1.99 (6.71)	-24.24 to 15.07	
FFM (Kg)			
Baseline	45.56 (5.45)	34.41 to 58.43	<0.001
Post-treatment	42.41 (5.94)	31.42 to 61.44	
Changes (%)	-6.98 (4.70)	-19.23 to 5.15	
FFM%			
Baseline	66.69 (8.19)	54.80 to 89.59	<0.001
Post-treatment	62.85 (8.79)	48.28 to 89.17	
Changes (%)	-5.66 (5.51)	-19.00 to 6.58	
FFMI (Kg/m^2)			
Baseline	17.38 (1.67)	14.09 to 21.35	<0.001
Post-treatment	16.16 (1.64)	12.95 to 19.58	
Changes (%)	-6.98 (4.70)	-19.23 to 5.15	
FM (Kg)			
Baseline	23.56(8.48)	5.37 to 39.38	<0.001
Post-treatment	25.82(9.04)	6.08 to 46.54	
Changes (%)	11.75 (9.03)	-34.74 to 59.18	
BF%			
Baseline	33.19(8.22)	10.41 to 45.19	<0.001
Post-treatment	36.97(8.82)	10.83 to 51.71	
Changes (%)	12.65 (15.70)	-30.32 to 56.43	
FMI			
Baseline	9.13 (3.47)	1.86 to 16.01	<0.001
Post-treatment	9.99 (3.67)	1.98 to 18.88	
Changes (%)	11.47 (19.05)	-34.74 to 59.18	

BMI: Body mass index; FFM: Fat-free mass; FFM%: Fat-free mass percentage; FFMI: Fat-free mass index; FM: Fat mass; BF%: Body fat percentage; FMI: Fat mass index.
**P*-values derived from Wilcoxon-signed rank test.

During the first cycle of NAC, 62 % of patients lost weight. The percentage of patients with low BMI, low muscle mass, and sarcopenic obesity significantly increased from baseline to four weeks after receiving NAC (9.4% vs. 11.5%; 16.7% vs. 33.3%; and 5% vs. 21.7%, respectively) **(Table 3)**.

Table 3. Patients' nutritional characteristics before and after the first cycle of neoadjuvant chemotherapy

Nutritional characteristics	Baseline %	Post-treatment %	*P*-values *
BMI categories#			
Without low BMI	90.6	88.5	<0.001
With low BMI	9.4	11.5	
Weight loss categories †			
Without weight loss	-	38.1	-
Low weight loss (<5%)	-	38.1	
Moderate weight loss (5-10%)	-	12.9	
Severe weight loss (>10%)	-	10.8	
Muscle mass (MM) categories §			
Normal MM	83.3	66.7	<0.001
Low MM	16.7	33.3	
Sarcopenic obesity (SO) ‡			
Without SO	95.0	78.3	<0.001
With SO	5.0	21.7	

**P*-value using the Chi-square test.

\# Low BMI :<20 if <70 years, or <22 if >70 years.[3]

†Weight loss: Low: <5%; Moderate: 5-10%; Severe: >10%.[3]

§ Low muscle mass or low fat-free mass index (FFMI, kg/m^2): < 17 kg/m^2 for men and <15 kg/m^2 for women.[3]

‡ A condition with both excess body fat levels [20] and low muscle mass.[3]

During the first cycle of NAC, men had a significantly higher risk for low muscle mass than women (odds ratio (OR): 8.14; 95 % confidence interval (95% CI): 1.47-45.18; *P* = 0.016). Patients aged 40-59 years were more likely than those aged 60-84 age to experience moderate or severe weight loss and muscle mass reduction (OR: 1.94; 95% CI: 0.75-5.03; and OR: 2.11; 95% CI: 0.56-7.91, respectively). Non-overweight patients had a higher risk of moderate or severe weight loss as well as low muscle mass than their overweight or obese counterparts (OR: 1.90; 95%CI: 0.86-4.19; and OR: 3.6; 95%CI: 6.89-18.12, respectively). Similarly, patients without excess body fat were more likely than those with excess body fat to experience moderate or severe weight loss and reduced muscle mass (OR: 3.50; 95%CI: 0.80-15.28; and OR: 6.64; 95%CI: 1.49-29.56, respectively).

With respect to tumor localization, patients with colorectal cancer had a 2.14 times greater risk of moderate to severe weight loss than patients with other cancer types. Contrarily, compared to patients with other cancer types, women with breast and uterine cancer had significantly lower odds of having low muscle mass (OR=0.07; 95%CI: 0.01-0.64; and OR=0.06; 95%CI: 0.01-0.82, respectively). Patients with cancer diagnosed within the first two years had a slightly lower risk of experiencing moderate to severe weight loss than patients diagnosed later in the disease course. As indicated in **Table 4**, Patients who were recently diagnosed as having cancer (<1 year and 1-2 years) had higher odds of having low muscle mass than those who had the disease for more than two years (OR=1.67; 95% CI: 2.29-9.42; and OR=2.45; 95% CI: 0.39-15.50, respectively).

Table 4. Predictors of moderate/severe weight loss and low muscle mass during the first cycle of neoadjuvant chemotherapy

Variables	Moderate/severe weight loss [a]				Low muscle mass [b]			
	%	OR[c]	95%CI[c]	*P-value*[c]	%	OR[c]	95%CI[c]	*P-value*[c]
Sex								
Men	28.6	1.35	0.48-3.81	0.573	75.0	8.14	1.47-45.18	0.016
Women	22.9	Ref.			26.9	Ref.		
Age								
27-39 yrs	20.0	1.14	0.29-4.45	0.847	30.0	1.39	0.24-8.07	0.712
40-59 yrs	24.2	1.94	0.75-5.03	0.171	39.4	2.11	0.56-7.91	0.267
60-84 yrs	11.8	Ref.			23.5	Ref.		
Weight status								

Non-overweight	30.5	1.90	0.86-4.19	0.110	69.2	3.6	6.89-18.12	<0.001
Overweight/obese	18.8	Ref.			5.9	Ref.		
Body fat levels								
Without excess	40.0	3.50	0.80-15.28	0.096	70.0	6.64	1.49-29.56	0.013
With excess [d]	16.0	Ref.			26.0	Ref.		
Tumor localization								
Breast	19.4	0.62	0.22-1.70	0.351	25.0	0.07	0.01-0.64	0.019
Colorectal	45.5	2.14	0.49-9.35	0.311	60.0	0.30	0.02-4.91	0.398
Uterus	30.0	1.10	0.22-5.51	0.906	22.2	0.06	0.01-0.82	0.035
Others[e]	28.0	Ref.			83.3	Ref.		
Time since cancer diagnosis								
< 1 yr	24.5	0.65	0.19-2.28	0.499	32.4	1.67	0.29-9.42	0.559
1-2 yrs	21.3	0.54	0.16-1.81	0.321	41.2	2.45	0.39-15.50	0.341
> 2 yrs	33.3	Ref.			22.2	Ref.		

[a] Moderate and severe weight loss: ≥ 5% of weight loss.[3]
[b] Low muscle mass or low fat-free mass index (FFMI, kg/m^2): < 17 kg/m^2 for men and <15 kg/m^2 for women.[3]
[c] Crude odds ratio (OR) and 95% confidence interval (95%CI) using logistic regression.
[d] Excess body fat levels: 20–39 years:>19 % and >32%; 40–59 years:>21% and >33%; 60–79 years: >24 % and >35% for men and women, respectively.[20]
[e] Include stomach, lung, gallbladder, bladder, intestine, tongue, pancreas, prostate, kidney cancer, and lymphoma.

This study was designed to investigate changes in body weight and body composition in cancer patients receiving neoadjuvant chemotherapy (NAC) and to examine the role of some factors as potential predictors of weight loss and muscle atrophy. Our results showed significant changes in patients' body composition over a period of four weeks after the first course of NAC. We found that patients lost 7% of FFM and gained 12% of FM on average, while their mean BMI decreased by only 2%. Such changes are unlikely to be detected by clinicians in the absence of significant variation in BMI, highlighting the importance of studying body composition over anthropometric measurements.[21] Although our data need to be validated by more accurate techniques such as magnetic resonance imagery,[22] they confirm that NAC may result in body composition modifications in favor of fat gain and lean body mass loss due to a variety of associated factors such as poor treatment tolerance, decreased muscle function, or hormonal alterations.[23]

Overall, our findings are consistent with previous studies, which found a significant decrease in body weight and FFM among cancer patients receiving neoadjuvant chemotherapy.[24, 25] Although other studies did not find such differences in patients receiving similar treatment,[26, 27] our data highlight the importance of body weight and FFM measurements as potentially useful indicators of nutritional status. According to Álvaro Sanz *et al*. and Kruizenga *et al*. using an early detection protocol after a cancer diagnosis can improve the recognition of malnourished patients by up to 80% and the effectiveness of nutritional interventions.[28, 29]

Despite the growing evidence that malnutrition among cancer patients has a negative impact on clinical outcomes and that nutritional interventions improve treatment tolerance, quality of life, and overall survival,[2] many malnourished patients are not identified and thus are not referred to dietitians for nutrition screening and timely nutritional therapy.[30] According to Cederholm *et al*. and Arends *et al*. the top five diagnostic criteria for malnutrition in clinical settings include weight loss, low BMI, and low muscle mass.[3, 5] In this study, we found that 86 patients (62%) lost weight between baseline and 4 weeks after receiving neoadjuvant chemotherapy. This result is consistent with previous research, which found a high prevalence of weight loss in patients receiving similar treatment.[20, 31] For instance, Fernández López *et al*. (2013) found that 69% of the patients had lost more than 5% of their usual weight within the three months following the start of chemotherapy, with 43% losing more than 10% of their body weight.[31]

The proportion of patients with low fat-free mass index (FFMI) increased from 16.7% before receiving neoadjuvant chemotherapy to 33.3% after treatment, while the percentage of subjects with low BMI increased by only 2.1%. Thus, the FFMI may provide more accurate information than the BMI from functional and metabolic points of view.[32]

Furthermore, of particular concern, the proportion of patients with sarcopenic obesity increased from 5.0% at baseline to 21.7% four weeks after completion of the NAC. Previous studies have demonstrated that sarcopenic obesity is strongly associated with adverse clinical outcomes and increased mortality in cancer patients.[10, 33] Although larger studies are needed to investigate the effect of changes in FFM and sarcopenic obesity in cancer patients, our study emphasizes the importance of identifying sarcopenic obese individuals early so that appropriate interventions can be implemented.

Logistic regression analysis revealed that men were more likely than women to lose weight and muscle mass. This is consistent with other studies that found that male cancer patients were more likely to be malnourished than female patients.[34, 35] Other authors, however, found null or inconclusive associations of sex with weight loss and low muscle mass.[11, 36] One possible explanation of our finding is that women undergoing NAC for breast cancer (66.9% of patients) may have gained weight as a result of hormone therapy. This could also be due to the NAC (with or without paclitaxel) used in our study, as well as the relatively short-duration treatment. Furthermore, a previous study of breast cancer patients found a significant change in body composition after adjuvant chemotherapy, with an increase in FM and a decrease in FFM.[37]

Contrary to previous studies,[25, 38] cancer patients aged 40-59 years tended to have an increased risk of losing weight and muscle mass compared to older patients. Dunne *et al*. (2019) discovered that cancer cachexia, as measured by weight loss, BMI, and skeletal muscle mass, is quite common in older adults.[38] Compounding the issue is that physiologic age-related loss of muscle mass and muscle function could occur as well, a process known historically as sarcopenia.[39] Thus, although our finding did not reach statistical significance, it is of critical importance and deserves to be addressed in further large studies.

We observed that non-overweight patients were more likely than overweight or obese patients to lose weight and muscle mass after receiving NAC. Similarly, individuals with no excess body fat had a higher likelihood of losing weight and muscle mass than those with excess body fat. This aligns with previous studies[40, 41] and confirms the established link between elevated BMI and better clinical outcomes in cancer patients receiving chemotherapy.[42] Thus, it may be important for overweight or mildly obese patients, undergoing chemotherapy to maintain their weight, while increasing lean body mass through healthy dietary intake, regular physical activity, and behavioral therapy.[43]

Previous literature has shown that the frequency of weight loss and low muscle mass since the first medical oncology visit varies by cancer type, as they likely have different effects in terms of mechanisms affecting dietary intake, disease burden, and inflammation.[6, 44] In this study, we found that patients with colorectal cancer were more than twice as likely as patients with other types of cancer to experience moderate or severe weight loss. Our results show that patients with colorectal cancer remain at a higher risk of losing weight and having less muscle mass, both of which are indicators of malnutrition.[45]

Another important finding was that patients with breast and uterine cancer were significantly less likely to have low muscle mass. Although we included 139 patients in the current analysis, the study population is heterogeneous, and our results should be interpreted with caution. Future research should consider assessing weight loss and muscle mass depletion in large samples of cancer patients at specific sites.

Compared to patients whose disease was diagnosed more than two years ago, patients who were recently diagnosed as having cancer (<1 year and 1-2 years) had a lower likelihood of weight loss and greater odds of low muscle mass. This is likely due to a combination of fat gain and fat-free mass loss, implying that these patients are at an increased risk of sarcopenic obesity.[46]

Limitations

Several limitations to our study should be mentioned. Firstly, we included a relatively small number of participants from a single hospital, and our analysis was limited to cancer patients who were eligible and consented to take part in our study. Secondly, this study assessed short-term but not long-term changes in body weight and body composition in patients receiving NAC. Thirdly, although bioelectrical impedance is a practical method and widely used for assessing body composition, it may result in measurement bias.[47] Finally, the current study did not collect data on dietary intake or physical activity, which is a limitation because both can influence body weight and muscle mass.[48, 49] Despite these limitations, our findings provide important information on cancer-related malnutrition that can help with the design and delivery of supportive care interventions for cancer patients.[50] Such findings may also help oncologists assess their patients' nutritional status more thoroughly.

Conclusion

In conclusion, our findings suggest that NAC may have a negative impact on nutritional status. Weight loss and low muscle mass were common in our study population. Our data highlight the importance of raising awareness about weight loss and body composition changes, as well as the importance of early nutritional interventions to address these risk factors for poor prognosis and quality of life among cancer patients.

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Conflict of interest

None.

Financial support

None.

Ethics statement

The study followed the ethical principles of the World Medical Association Declaration of Helsinki and was approved by the Biomedical Research Ethics Committee of the Faculty of Medicine and Pharmacy in Rabat (Certificate number: 99/22). Prior to data collection, all invited participants were informed about the research objectives and methods, and each patient involved in the study provided a written consent.

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