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Body Composition and Metabolic Profile during Chemotherapy in Early-Stage Breast and Cervical Cancer Patients in Douala, Cameroon: A Hospital-Based Study

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Abstract

Background: *Changes in body composition during chemotherapy can adversely affect the prognosis of cancer patients. To evaluate these changes, a case-control study was conducted in the cobalt therapy departments of Douala General Hospital. The primary objective was to assess the impact of chemotherapy and disease stage on body composition changes in women with breast or cervical cancer treated at the hospital's oncology unit.*

Methods: *Muscle mass, body fat, and body water percentages were measured using the bioelectrical impedance analysis (BIA) method, and blood samples were collected to determine albumin and creatinine concentrations. The data were analyzed using SPSS version 16 for Windows (SPSS, IBM, Chicago, IL, USA).*

Results: *The study revealed that the mean age of breast cancer (BC) patients was 44.62±11.23 years, cervical cancer (CC) patients 50.37±10.78 years, and controls 46.11±10.43 years. Muscle mass, body fat, and body water percentages significantly decreased in cancer patients compared to controls ($p=0.0028$, $p=0.004$, and $p=0.004$, respectively). In BC patients, muscle mass significantly declined between stages 1 and 2 ($p=0.001$), while no significant changes were observed in CC patients ($p=0.84$). Body fat and body water percentages did not significantly change between stages 1 and 2 for either cancer type. Metabolically, creatinine levels were significantly elevated ($p<0.001$) and albumin levels significantly reduced ($p<0.001$) in cancer patients compared to controls. Between stages 1 and 2, creatinine levels showed a non-significant increase in BC patients ($p=0.08$) and a non-significant decrease in CC patients ($p=0.95$). Albumin levels significantly decreased in CC patients ($p=0.01$) but not in BC patients ($p=0.55$).*

Conclusion: *Chemotherapy leads to significant changes in body composition and metabolic profiles in early-stage breast and cervical cancer patients, emphasizing the need for regular monitoring during treatment.*

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Introduction

Changes in body composition during chemotherapy significantly impact patients' vital prognosis, as shown by multiple studies [1-7]. The model described by Kaffel et al. (2021) highlights the importance of adipose tissue, muscle mass, and water in analyzing body composition during chemotherapy [8]. Body water is essential for therapeutic molecule elimination and maintaining renal clearance, while muscle mass supports immune regulation, reduces chemotherapy side effects, and improves prognosis [9-13]. Conversely, adipose tissue contributes to oxidative stress and drug toxicity, making it a less reliable prognostic marker [14,15].

These changes are both physical and metabolic, with biomarkers such as creatinine, vitamin D, leptin, and albumin playing critical roles. Creatinine clearance is predictive of chemotherapy side effects, drug toxicity, and overall survival [16-18]. Albumin serves as a reliable prognostic and survival marker during treatment [19,20].

In Cameroon, breast and cervical cancers are leading causes of cancer-related deaths among women, resulting in 2,108 and 1,787 deaths respectively in 2020 [21]. Despite being the most common treatment, chemotherapy in Cameroon has a low therapeutic success rate, with most patients succumbing within a year of therapy initiation.

Given these challenges, this study aimed to assess the impact of chemotherapy and disease stage on body composition changes in women with breast or cervical cancer treated at Douala General Hospital.

Material and Methods

Study Site

The study took place from November 2023 to April 2024 at Douala General Hospital's oncology department in Cameroon, a leading first-class hospital offering specialized cancer treatments, including surgery, radiotherapy, and chemotherapy. The hospital was chosen for its high patient volume, drawing individuals from Cameroon and Central Africa.

Study Population

The study included three groups of women. The first two groups comprised women with breast or cervical cancer, confirmed through histological and biological diagnosis by the researcher or colleagues in the department, who were undergoing chemotherapy or referred for follow-up from other oncologists in Cameroon or the Central African sub-region. The third group consisted of women without cancer or clinical signs of recurrent disease, including nurses, care assistants, or sick call nurses who provided informed consent. Women who declined to participate by withholding consent were excluded, without affecting the quality of care provided. The sample size was determined based on convenience, including a total of 109 women.

Study Design

To assess the impact of chemotherapy on body composition, we conducted a case-control study. Cases were women newly diagnosed with breast or cervical cancer who consented to participate, while controls were healthy women meeting WHO criteria, recruited from the same hospitals [22].

Data Collection

A structured questionnaire collected data on sociodemographic, body composition, clinical details, and creatinine and albumin concentrations from patients after informed consent. It included information on marital status, education, occupation, cancer type, stage, treatment protocol, and biochemical markers.

Measuring the Components of Body Composition

Muscle mass, body fat an body water percentages have been measured by bioimpedance analysis (BIA) using a calibrated system of equations by DXA (Dual-energy X-ray absorptiometry) to calculate muscle mass as proposed by Janssen et al, body fat percentage and body water percentage [23-25].

Measuring of Creatinine and Albumin Concentrations

Blood samples (4 mL) were collected, processed, and analyzed for creatinine and albumin using the Jaffé and colorimetric methods, respectively [26,27].

Statistical Analyses

Data were entered into an Excel sheet (Microsoft Office, USA) and subsequently analyzed with SPSS version 16 for Windows (SPSS, IBM, Chicago, IL, USA). The qualitative and quantitative variables were presented as mean ± standard deviation (SD) and percentage, respectively.

The one-way analysis of variance (ANOVA) was used to compare means and subsequently Duncan's post hoc test was used to make pairwise comparisons. The non-parametric Mann-Whitney test was used to make comparisons when the ANOVA could not be used. The Pearson correlation was used to study the relationship between the different parameters. The significance level was set at $P < 0.05$.

Results

Selection Procedure for Newly Diagnosed Cancer Patients Included in the Study

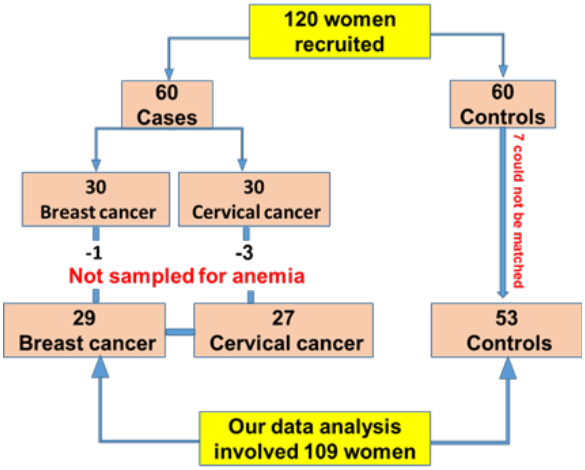


Figure1: Recruitment Diagram for Patients Included in our Study

A total of 120 women were recruited during the study period: 60 women newly diagnosed with breast cancer (30) or cervical cancer (30) and 60 control women from the hospital. During data collection, one breast cancer patient and three cervical cancer patients were excluded due to anemia. Among the controls, seven women did not meet the matching criteria for age and body mass. Additionally, four and seven controls were excluded during data analysis. Ultimately, data from 109 women were analyzed (Figure 1)

Socio-Demographic Characteristics of Participants

Table 1 summarizes the sociodemographic characteristics of the study participants. The mean age was 45±11 years for breast cancer patients, 50±11 years for cervical cancer patients, and 46±10 years for controls. A comparison of the three mean ages using the Kruskal-Walli's rank sum test revealed no statistically significant differences (p=0.094; 95% CI). The majority of participants were married, had a secondary level of education, were unemployed, worked as housekeepers, and resided in Douala (table1).

Table 1: Socio-Demographic Characteristics of Participants

Parameters	Overall (N = 109)	Breast cancer (N = 29)	Cervical cancer (N = 27)	Control (N = 53)	P-value
Age	47±11	45±11	50±11	46±10	0.094
Marital status					**0.12**
Married	50% (55/109)	52% (15/29)	37% (10/27)	57% (30/53)	
Celibate	42% (46/109)	34% (10/29)	52% (14/27)	42% (22/53)	
Widow	4.6% (5/109)	6.9% (2/29)	7.4% (2/27)	1.9% (1/53)	
Separate	1.8% (2/109)	6.9% (2/29)	0% (0/27)	0% (0/53)	
Divorce	0.9% (1/109)	0% (0/29)	3.7% (1/27)	0% (0/53)	
Level of study					**0.059**
Secondary	45% (49/109)	66% (19/29)	37% (10/27)	38% (20/53)	
Higher	38% (41/109)	17% (5/29)	41% (11/27)	47% (25/53)	
Primary	17% (19/109)	17% (5/29)	22% (6/27)	15% (8/53)	
Sector Of Activity					**0.3**
Jobless	44% (48/109)	31% (9/29)	59% (16/27)	43% (23/53)	
Informal	37% (40/109)	48% (14/29)	30% (8/27)	34% (18/53)	
Formal	19% (21/109)	21% (6/29)	11% (3/27)	23% (12/53)	
Profession					**na**
Housekeeper	30% (33/109)	21% (6/29)	33% (9/27)	34% (18/53)	
Saleswoman	19% (21/109)	31% (9/29)	11% (3/27)	17% (9/53)	
Student	13% (14/109)	10% (3/29)	22% (6/27)	9.4% (5/53)	
Teacher	8.3% (9/109)	3.4% (1/29)	7.4% (2/27)	11% (6/53)	
Hotels	4.6% (5/109)	10% (3/29)	0% (0/27)	3.8% (2/53)	
Accountant	3.7% (4/109)	0% (0/29)	3.7% (1/27)	5.7% (3/53)	
Couturier	3.7% (4/109)	0% (0/29)	0% (0/27)	7.5% (4/53)	
Hairdresser	2.8% (3/109)	3.4% (1/29)	3.7% (1/27)	1.9% (1/53)	
Nurse	2.8% (3/109)	3.4% (1/29)	0% (0/27)	3.8% (2/53)	
Secretary	1.8% (2/109)	0% (0/29)	3.7% (1/27)	1.9% (1/53)	
Executive Assistant	0.9% (1/109)	3.4% (1/29)	0% (0/27)	0% (0/53)	
ATMs	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Call Box	0.9% (1/109)	0% (0/29)	3.7% (1/27)	0% (0/53)	
Communicator	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Cultivator	0.9% (1/109)	0% (0/29)	3.7% (1/27)	0% (0/53)	
Gendarme	0.9% (1/109)	3.4% (1/29)	0% (0/27)	0% (0/53)	
Institute	0.9% (1/109)	0% (0/29)	3.7% (1/27)	0% (0/53)	
Pharmacist	0.9% (1/109)	3.4% (1/29)	0% (0/27)	0% (0/53)	
Plantation Eve Cam	0.9% (1/109)	3.4% (1/29)	0% (0/27)	0% (0/53)	
Stylist	0.9% (1/109)	0% (0/29)	3.7% (1/27)	0% (0/53)	

Surface Technician	0.9% (1/109)	3.4% (1/29)	0% (0/27)	0% (0/53)	
Town Of Residence					**0.03***
Douala	54% (59/109)	52% (15/29)	70% (19/27)	47% (25/53)	
Yaounde	9.2% (10/109)	17% (5/29)	0% (0/27)	9.4% (5/53)	
Bamenda	4.6% (5/109)	10% (3/29)	7.4% (2/27)	0% (0/53)	
Bafang	2.8% (3/109)	0% (0/29)	3.7% (1/27)	3.8% (2/53)	
Buea	2.8% (3/109)	6.9% (2/29)	0% (0/27)	1.9% (1/53)	
Dschang	2.8% (3/109)	0% (0/29)	3.7% (1/27)	3.8% (2/53)	
Bafoussam	1.8% (2/109)	3.4% (1/29)	0% (0/27)	1.9% (1/53)	
Kribi	1.8% (2/109)	3.4% (1/29)	3.7% (1/27)	0% (0/53)	
Kumba	1.8% (2/109)	0% (0/29)	0% (0/27)	3.8% (2/53)	
Mbouda	1.8% (2/109)	3.4% (1/29)	0% (0/27)	1.9% (1/53)	
North	1.8% (2/109)	0% (0/29)	0% (0/27)	3.8% (2/53)	
Tiko	1.8% (2/109)	0% (0/29)	0% (0/27)	3.8% (2/53)	
Bagangte	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Bawoung	0.9% (1/109)	0% (0/29)	3.7% (1/27)	0% (0/53)	
Edea	0.9% (1/109)	0% (0/29)	3.7% (1/27)	0% (0/53)	
Foumbam	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Garoua	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Kousseri	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Libreville	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Limbe	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Mebealem	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Moyoka	0.9% (1/109)	0% (0/29)	3.7% (1/27	0% (0/53)	
Nkongsamba	0.9% (1/109)	3.4% (1/29)	0% (0/27)	0% (0/53)	
Penja	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	
Pinyin	0.9% (1/109)	0% (0/29)	0% (0/27)	1.9% (1/53)	

Continuous data were presented in the form of mean and standard deviation (Mean±SD). Categorical data were presented in the form of percentage and frequency (% (n/N)). P-value: continuous data (Kruskal-Walli's rank sum test); categorial data (Fisher's exact test).

Clinical Characteristics of Patients

Table 2 presents the clinical characteristics of the patients. The most common number of treatments in both groups was 3 (16 patients or 28.5%), followed by 4 (11 patients or 19.5%), 6 (9 patients or 16.1%), and 5 (5 patients or 8.9%). The most frequently observed stage was stage I (34 patients or 60.7%), followed by stage II (18 patients or 32.1%). Stages 0 and III were the least represented, with 1 and 3 patients respectively, accounting for a cumulative total of 7.2% (Table 2).

Table 2 : Clinical Characteristics of Patients

Variables	Breast cancer (n = 29)		Cervical cancer (n = 27)		Total (n = 56)	
	N	%	n	%	n	%
Number of chemotherapy						
1	3	10,3	0	0.0	3	5.4
2	2	6.9	1	3.7	3	5.4
3	8	27.7	8	29.6	16	28.5
4	3	10.3	8	29.6	11	19.5
5	3	10.3	2	7.4	5	8.9
6	4	13.9	5	18.6	9	16.1
7	0	0.0	2	7.4	2	3.6
8	2	6.9	0	0.0	2	3.6
9	2	6.9	0	0.0	2	3.6
10	1	3.4	0	0.0	1	1.8
11	1	3.4	0	0.0	1	1.8
31	0	0.0	1	3.7	1	1.8
Stage of cancer						
0	0	0.0	1	3.7	1	1.8
1	19	65.5	15	55.6	34	60.7
2	8	27.6	10	37.0	18	32.1
3	2	6.9	1	3.7	3	5.4

Body Composition and Metabolic Profile in Cases and Controls

Table 3 presents a comparative analysis of body composition parameters (muscle mass, body fat percentage, and body water percentage) and metabolic profiles (creatinine and albumin concentrations) between cases and controls. Muscle mass, body fat, and body water percentages in breast and cervical cancer patients undergoing chemotherapy differed significantly from those of the controls. Similarly, creatinine and albumin concentrations in these patients were significantly different from those of the controls (table3).

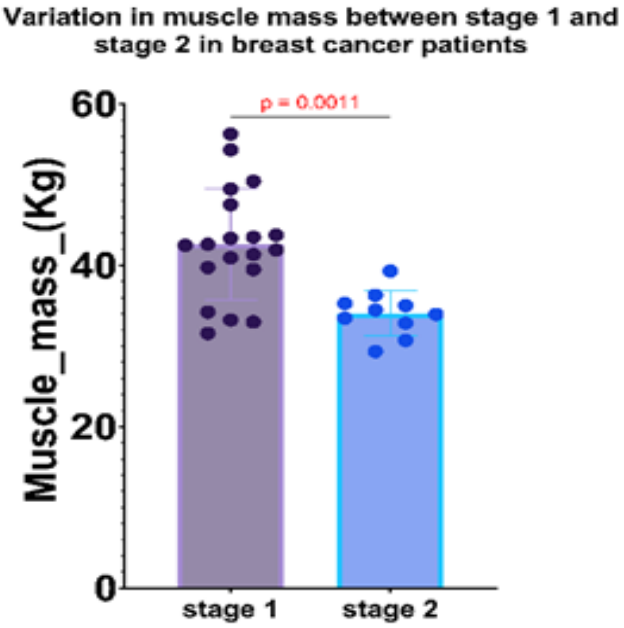
Table 3: Muscle Mass, Body Fat Percentage, Body Water Percentage, Creatinine and Albumin Concentration in Cases and Controls

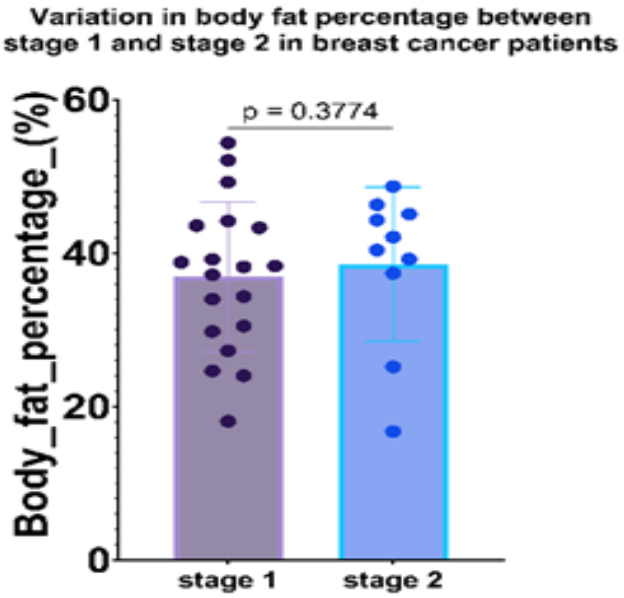
Parameters	Participants		
	Breast Cancer (n=29)	Cervical Cancer (n=27)	Controls (n=53)
Muscle mass (Kg)	39,65 ± 7,07^{b}	38,18 ± 4,87^{b}	44,73 ± 8,12^{a}
Body fat percentage (%)	37,47 ± 9,70^{b}	37,55 ± 6,78^{b}	42,33 ± 5,86^{a}
Albumin (g/dl)	3,49 ± 0,89^{b}	3,85 ± 1,14^{b}	4,55 ± 0,69^{a}
Creatinine (mg/dl)	0,90 ± 0,33^{b}	0,93 ± 0,38^{b}	0,55 ± 0,15^{a}
Body water percentage	37,40 ± 6,56^{b}	38,45 ± 6,23^{ab}	40,96 ± 4,28^{a}

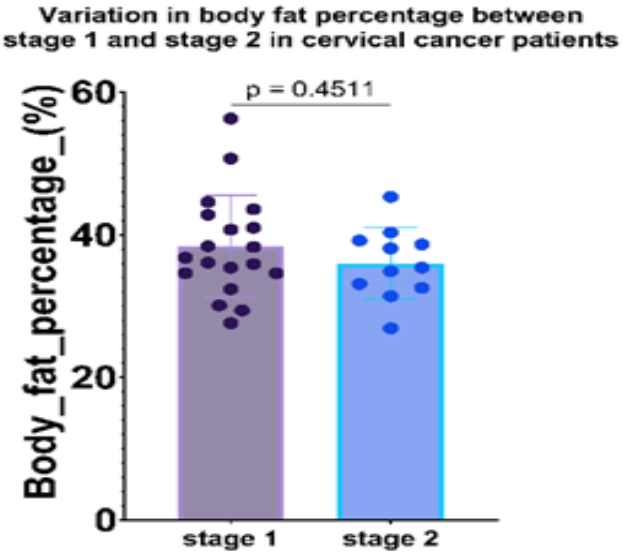
Data are presented as mean ± standard deviation (SD); ordered analysis of variance and Duncan's post hoc test were used to make comparisons. For the same line, figures bearing the same letter are not statistically significant at P < 0.05

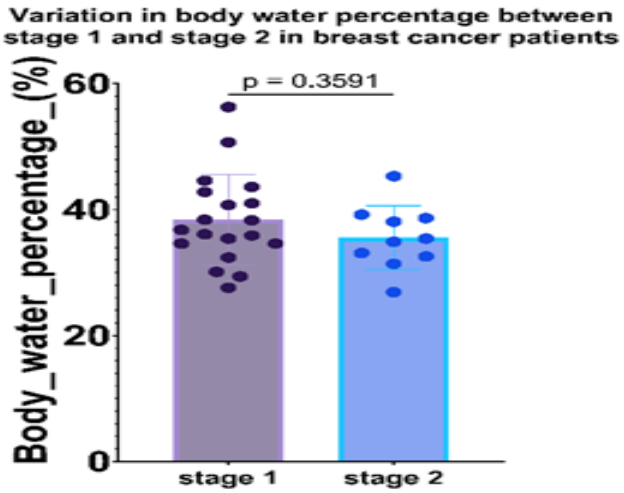
Variation In Body Composition and Metabolic Profile between Stages 1 and 2 of the Disease in Patients with Breast or Cervical Cancer

Figures 2 and 3 highlight the changes in body composition and metabolic profiles between stages 1 and 2 in breast and cervical cancer patients. Muscle mass significantly decreased in breast cancer patients (p=0.001) but showed no significant change in cervical cancer patients (p=0.91). Body fat percentage slightly increased in breast cancer patients (p=0.37) and decreased in cervical cancer patients (p=0.45), with neither change being significant. Similarly, body water percentage decreased in both groups without reaching statistical significance (breast cancer: p=0.35, cervical cancer: p=0.15). In terms of metabolic profiles, creatinine concentrations increased non-significantly in both breast cancer (p=0.09) and cervical cancer patients (p=0.76). Albumin concentrations increased non-significantly in breast cancer patients (p=0.54) but significantly decreased in cervical cancer patients (p=0.01).









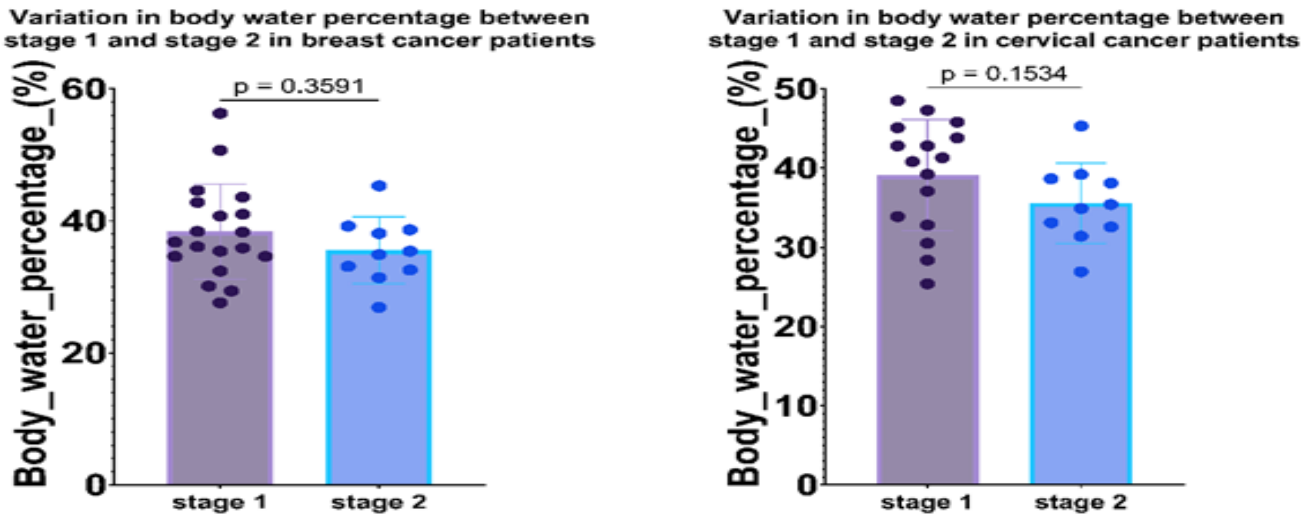


Figure 2: Variation in Muscle Mass, Percentage of Body Fat and Body Water Between Stage 1 and Stage 2 Disease in Patients with Breast and Cervical Cancer

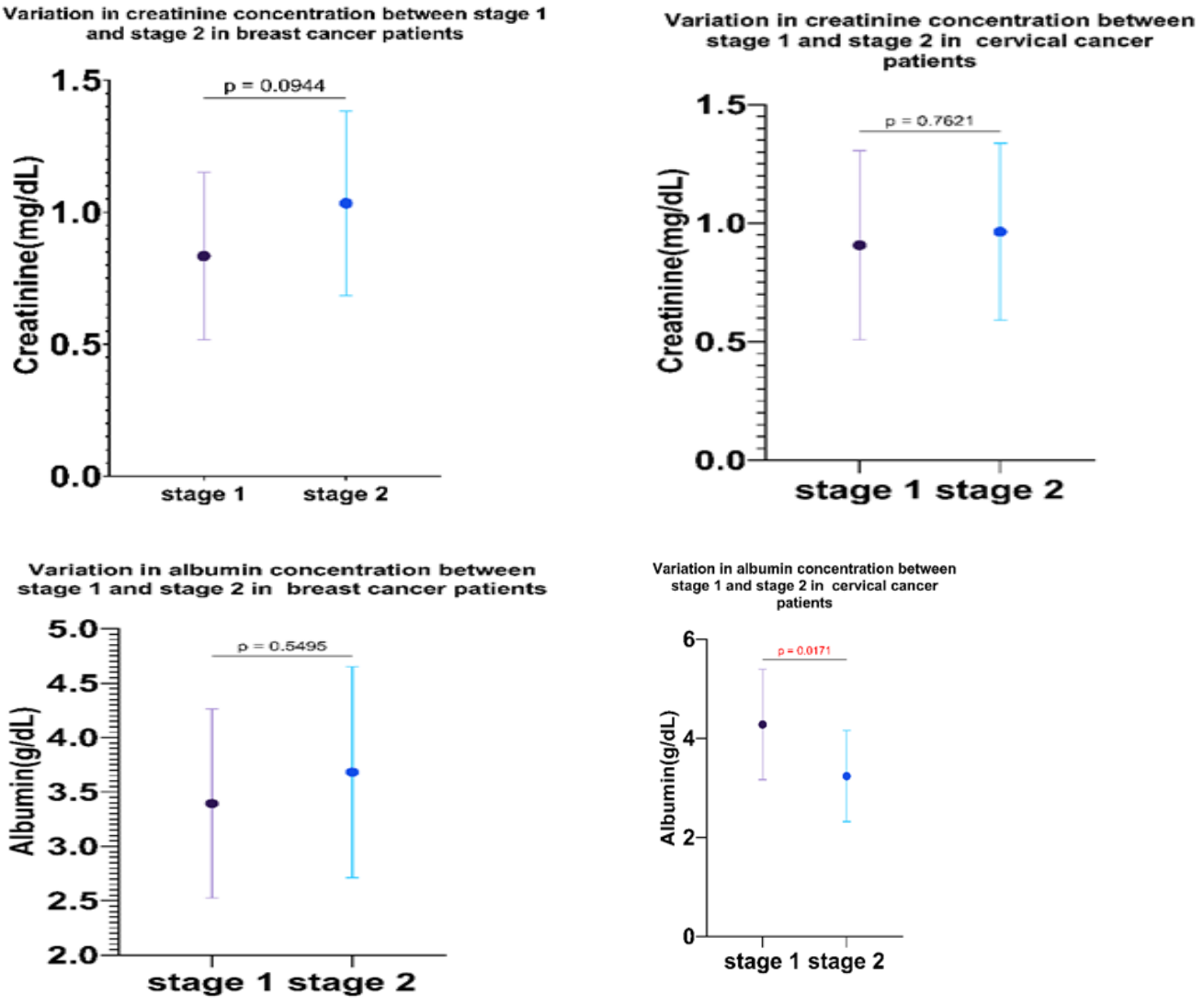


Figure 3: Variation in Percentage Creatinine and Albumin Concentrations Between Stage 1 And Stage 2 Disease in Patients with Breast and Cervical Cancer

Discussion

Breast and cervical cancers are the leading causes of cancer-related deaths among women worldwide and particularly in Cameroon. In this country, where the therapeutic index of anticancer treatments remains low, cancer mortality rates are alarmingly high. Our study aimed to contribute to scientific knowledge on how changes in body composition affect the response to chemotherapy in breast and cervical cancer patients. A case-control study was conducted to determine the impact of chemotherapy and disease stage on body composition changes in women treated at the oncology unit of Douala General Hospital.

On the sociodemographic aspect, the mean age of breast cancer patients was 45±11 years, cervical cancer patients 50±11 years, and controls 46±10 years. These mean ages were not statistically different (p=0.09), as cases and controls were age-matched to better analyze body composition changes. These findings are consistent with previous studies conducted in the same hospital and other regions of Cameroon [28,29]. Younger patients tend to tolerate chemotherapy side effects better than older patients, as age significantly influences body composition. Roberto Buffa et al. (2011) observed that increasing age leads to a decline in muscle mass and body water and a gain in body fat [30]. However, tumor progression and chemotherapy can induce significant changes in body composition regardless of age [3-5].

Body composition analysis using bioimpedance in breast and cervical cancer patients undergoing chemotherapy showed a significant decrease in muscle mass compared to controls and between stages 1 and 2 of the disease. These findings align with Rier et al. (2018), who reported similar results [31]. This decrease may result from tumor progression or the effects of therapeutic agents, leading to the loss of structural and metabolic muscle proteins, mitochondrial dysfunction, impaired oxidative phosphorylation, and disruptions in fatty acid metabolism [32]. Other mechanisms suggest that muscle proteins are broken down to support energy needs, angiogenesis, and tumor progression [33]. Inflammation is also implicated, with elevated levels of C-reactive protein, a fibrinogen, affecting both muscle protein degradation and synthesis via multiple signaling pathways [34,35]. Molecular analyses show increased expression of muscle atrophy genes such as atrogin-1 and MuRF-1, as evidenced by elevated mRNA levels in cancer patients (36.37).

Body fat percentage was significantly lower in cancer patients compared to controls, with a non-significant decrease between stages 1 and 2. Ginzal et al. and Halpern-Silveira et al. (2020) reported similar findings of fat loss during chemotherapy [38,39]. However, a recent meta-analysis indicated a gain in fat mass during chemotherapy, possibly due to cyclophosphamide-based protocols [40].

Body water percentages were significantly lower in patients compared to controls and showed a non-significant decrease between stages 1 and 2. This suggests insufficient hydration during chemotherapy, which is critical for drug clearance and optimal renal function.

Metabolic profile analysis revealed elevated creatinine concentrations in cancer patients compared to controls, with no significant changes between stages 1 and 2. Chauhan et al. (2016) observed that mean creatinine values remained within the normal range during treatment [41]. Similarly, Olubumni et al. (2018) reported significantly higher creatinine levels in cancer patients (p=0.02) [42]. These findings suggest that cancer cells utilize muscle-derived energy, with

ADP coupling with creatine phosphate via creatine kinase, resulting in increased creatinine production.

Serum albumin concentrations significantly decreased in cervical cancer patients during chemotherapy (from 4.33±1.12 g/dL in stage 1 to 3.15±0.93 g/dL in stage 2; p=0.01) but showed no significant change in breast cancer patients (from 3.60±0.86 g/dL in stage 1 to 3.37±0.68 g/dL in stage 2; p=0.55). These results align with Yadav et al. (2016), who attributed reduced albumin levels to anorexia and decreased food intake during cancer treatment [41]. Albumin, a marker of muscle metabolism, also possesses antioxidant and anti-inflammatory properties. Its reduction may be linked to increased production of reactive oxygen species and free radicals during chemotherapy [43].

Limitations

This work was inspired by my therapeutic follow-up sessions with these patients. We noted some limitations during the study such as the fact that we worked at the early stages of the disease. We intend to explore in a future study the changes in body composition from stage 1 to stage 4 of the disease in order to better appreciate these changes and take related measures.

Conclusion

The components of body composition assessed during our study (muscle mass, percentage of body fat and body water) associated with the metabolic profile (creatinine and albumin concentrations) decreased significantly in early-stage breast and cervical cancer patients undergoing chemotherapy compared with cancer-free women not undergoing chemotherapy, and non-significantly between stage 1 and stage 2 of the disease. Chemotherapy and tumor progression therefore had a negative impact on changes in body composition.

Data Availability

The data used to support the results of this study are available from the corresponding author on reasonable request..

Ethical Approval and Consent to Participate

This study was conducted according to the guidelines for clinical research on experimental models for clinical research on humans as indicated by the Ministry of Public Health of Cameroon. Administrative authorizations were issued by the institutional human health research ethics committee of the University of Douala (N° 3050 CEI-Udo/04/2022/T) and the Douala General Hospital (N°458 AR/MINSANTE/HGD/DM/08/22).

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contributions

DA, EDB and WSNM conceived the idea and the study. DA, JCM, AMMM and WSNM collected and entered the data in the field. PN and EDB supervised data collection in the hospitals. Author DA coordinated data entry, WSNM created figures, performed statistical analyses and interpreted the results with the help of DA. DA drafted the first version of the manuscript with the help of WSNM. Authors EDB, PN, JCM and AMMM reviewed the paper for important intellectual content. Authors EDB and PN supervised the work at all stages. All authors read and approved the final document before submission.

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Funding Declaration

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