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Hematological and biochemical abnormalities among women with breast cancer

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ABSTRACT
Background: Breast cancer is a complex and heterogeneous disease characterized by the abnormal proliferation of breast tissue, leading to tumor formation. It is the most common cancer diagnosis among women worldwide. Assessment of hematological and biochemical parameters can predict the severity, mortality, and follow-up treatment in women with breast cancer. ***The aim:*** The study aimed to evaluate hematological and biochemical parameters as useful markers among patients with breast cancer compared to healthy individuals**.** ***Methods***: A total of 124 women diagnosed with breast cancer attended The Department of National Cancer Institute Sabratha (NCI), from November 2024 to March 2025, and 50 healthy controls from The Libyan Medical Centre at Zawia city were also involved in this study. Demographic and clinical data, including complete blood count, liver function, and kidney function, were obtained from these patients. ***Results***: A significant decrease ($P< 0.001$) was observed in patients in terms of RBC HGB, HCT, MCV, and MCHC. On the other hand, platelet count (PLT) and lymphocytes were significantly higher in the patient groups than in controls ($P<0.001$ and $P<0.5$), respectively. Glucose and sodium levels were significantly lower in breast cancer patients (P 0.013 and $P<0.001$, respectively.
Conclusion: Routine blood testing represents one of the most accessible and essential diagnostic tools. Hematological and biochemical parameters may serve as valuable indicators to differentiate breast cancer patients from healthy individuals.
Keywords. *Breast cancer, hematological parameters, biochemical parameters*, and age

Introduction

Breast cancer is the most commonly diagnosed cancer in women worldwide and is the second leading cause of mortality in women around the world [1]. According to the GLOBOCAN 2022, breast cancer continues to rank as a major global health problem [2]. The incidence of breast cancer diverse by region and human development index (HDI). Notably, higher prevalence rates in more developed regions, however, higher mortality rates in lower-HDI regions, because of the disparities in access to early diagnosis and treatment [3]. Although the main causes of breast cancer in women are still unclear, nonhereditary causes and risk factors remain the predominant cause. These include early menarche, hormone intake, nutrition, alcohol consumption, smoking, and obesity, all of which are generally reported as risk factors [4]. Several studies have identified that the risk factors of breast cancer are associated with various causes, late age of first full-term (if any) pregnancy, short periods of breastfeeding, dietary routine, quality and composition of meals, physiologic factors, lower age at menarche, and later menopause [5].

Hematological parameters are measurements of blood components that assess the physiological and pathological state of the body. These parameters include red blood cells (RBCs), white blood cells (WBCs), platelets (Bp), hemoglobin (Hb), among others [6]. Biochemical parameters related to glucose metabolism and the kidney Functions are increasingly recognized as clinically relevant in breast cancer. Dysregulated glucose levels, particularly elevated fasting or random glucose, have been linked to increased breast cancer risk through mechanisms involving hyperinsulinemia and inflammation [7,8]. Kidney-related parameters such as urea and creatinine may also show alterations in cancer patients, indicating metabolic stress or treatment effects. Together, these markers can contribute to early detection and ongoing clinical assessment in breast cancer care [9]. Both previous parameters are clinically important because disparities from normal values can provide insights into inflammation, immune response, infection, anemia, and other systemic conditions [1]. Numerous studies have revealed that cancers influence the composition, function, and behavior of blood components and related markers. This relationship is significant

valued for diagnostic, prognostic purposes well as for monitoring cancer progression and treatment outcomes

[10]. Thus, the aim of this study was to assess the prognostic significance of hematological and biochemical

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parameters in patients with breast cancer relative to healthy individuals.

Materials and Methods

Ethical consideration

The interview starts after the explanation of the study's aims and objectives to the participants. The participants were given assurances regarding the confidentiality of the data collected. The ethics approval has been granted to the student from the local committee and the Human Research Ethics Committee at NCI, Sabratha under reference number (3/475).

Study design

This was a retrospective study conducted in the Department of National Cancer Institute Sabratha (NCI). A 124 women with breast cancer as the case group and 50 healthy women as control group obtained from Libyan Medical Centre at Zawia city from November 2024 to March 2025. Both groups were matched for age. All study participants with breast cancer were clinically diagnosed and referred to the laboratory for blood assessment. Informed consent were taken from patients.

Blood samples

Venous blood samples were drawn from the patients into sterile standard tubes containing ethylenediaminetetraacetic acid (EDTA) as an anticoagulant. Hematological parameters include complete blood count (CBC), hemoglobin (HGB) levels, red blood cell (RBC) count, hematocrit (HCT), white blood cell count, and lymphocyte percentages were analyzed using the Sysmex KX-21N™ automated hematology analyzer system. Biochemical parameters including creatinine, urea, glucose, sodium and potassium was also analyzed.

Statistical analysis

Data obtained from 124 BC patients and 50 healthy controls were analyzed using the Statistical Package for the Social Sciences (SPSS 27). Descriptive statistics, including means and standard deviations, were computed to summarize the continuous variables, while frequencies and percentages were calculated for categorical variables. Independent sample t-tests were conducted to compare the mean values of hematological and biochemical parameters between the experimental (breast cancer patients) and control groups. *P*-values less than 0.05 were considered statistically significant.

Results

Baseline Characteristics

Table 1 summarizes the demographic characteristics of the study participants. The mean age of breast cancer patients was 49.7 ± 9.0 years, with the majority falling within the 45–55-year age group. A statistically significant difference was observed among age groups ($P< 0.001$). Regarding family history, most patients reported no family history of breast cancer, with a significant difference noted across groups ($P< 0.001$). The results also indicated that obesity was prevalent among breast cancer patients, showing a significant association within this category ($P< 0.001$).

Table 1. Demographic features of the participants in this study

Variable	Value	Chi square	P value
Age(years);Mean SD	49.7 ± 9.0 y		
Age group n(%)			
25-35	6(4.8)	47.290	< 0.001
36-45	31(25.0)		
46-55	41(33.1)		
56-65	39(31.5)		
66-75	7(5.6)		
Family history n (%)			
First degree	26(20.9)	58.081	< 0.001
Second degree	17(13.7)		
No relationship	81(65.3)		
BMI n (%)			
Normal weight	13(20.0)	14.431	< 0.001
Overweight	16(24.6)		
Obesity	36(55.4)		

Hematological Parameters of Breast Cancer Patients

Table 2 presents the comparison of hematological parameters between breast cancer patients and controls. No statistically significant differences were observed between the two groups in white blood cell count (WBC), mean corpuscular hemoglobin (MCH), and neutrophil percentage ($P = 0.293$, $P = 0.728$, and $P = 0.62$, respectively). In contrast, breast cancer patients exhibited a significant decrease in red blood cell count (RBC), hemoglobin (HGB), hematocrit (HCT), mean corpuscular volume (MCV), and lymphocyte percentage compared to controls ($P < 0.001$, Fig 1). Conversely, platelet count and

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mean corpuscular hemoglobin concentration (MCHC) were significantly higher in breast cancer patients than in the control group ($P < 0.0001$ and $P < 0.001$, respectively).

Table 2. Hematological parameters of BC patients (N=124) and controls (N=50)

Parameters	Groups	N	Mean	Std	T value	P value
WBC count (10^3/µL)	BC Patients	105	6.74	3.905	-1.054	0.293
	Control	50	7.37	2.294		
RBC 10^6/µL	BC Patients	104	4.00	0.729	-3.259	<0.001
	Control	50	4.40	0.675		
Hgb g/dL	BC Patients	105	11.53	1.685	-4.755	< 0.001
	Control	50	12.60	1.075		
HCT%	BC Patients	105	33.61	4.328	-9.519	< 0.001
	Control	50	39.30	2.982		
MCVµm^3	BC Patients	104	83.42	7.217	-4.120	< 0.001
	Control	50	88.07	4.936		
MCH pg	BC Patients	104	28.44	4.185	0.348	0.728
	Control	50	28.27	1.999		
MCHC g/dL	BC Patients	104	37.55	2.285	9.18	<0.0001
	Control	50	30.83	4.928		
PLT(10^3/µL)	BC Patients	103	306.12	133.918	3.717	< 0.001
	Control	50	247.55	60.879		
Lymphocyte (10^3/µL)	BC patients	94	31.32	11.144	2.2026	0.0294
	Control	50	34.96	8.396		
Neutrophil (10^3/µL)	BC patients	91	58.83	14.161	0.497	0.62
	Control	48	57.89	8.141		

Blood values in BC patients and control were analyzed with independent Student's t-test; P<0.005 was considered a significant. Data were expressed as mean and Std. WBC: white blood cell count; PLT=Platelet; Neut = Neutrophils; Lymph = Lymphocyte.

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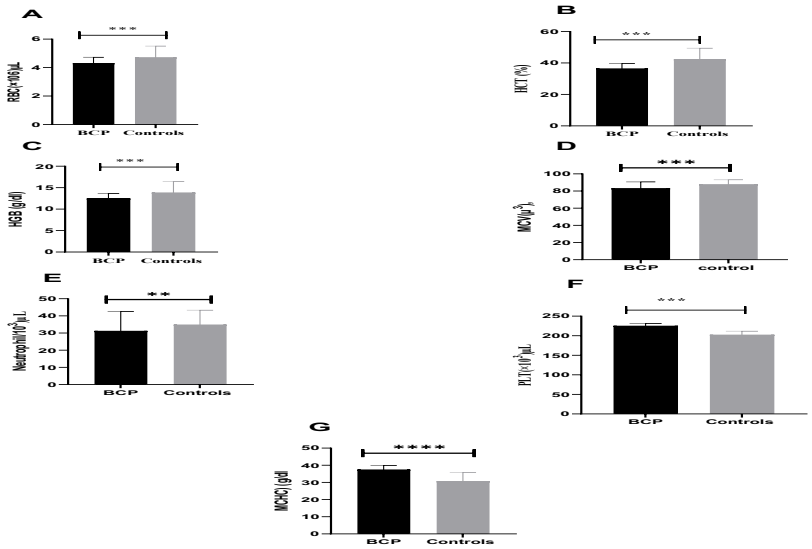

Figure 1: The bar charts illustrate the differences in the mean ±SE of CBC parameters between healthy controls and BCP patients. (A), RBC (B), HCT(C), HGB (D), MCV (E), neutrophils (F), PLT (E), MCHC. **P,0.05, ***P < 0.001 and ****P>0.0001

Biochemical Parameters of Breast Cancer Patients

Table (3) presents the comparison of biochemical parameters between breast cancer patients and healthy controls. Several parameters demonstrated variations of potential physiological and clinical relevance. A statistically significant difference was observed in glucose and sodium levels between the two groups (P = 0.013 and P < 0.001, respectively, Fig 2), indicating notable alterations in metabolic and electrolyte profiles among breast cancer patients.

Table 3. Evaluation of biochemical parameters in BC patients and Control Groups

Parameters	Group	N	Mean	Std	T value	P value
Glucose	**BC patients**	77	122.36	48.838	-2.509	0.013
	Control	49	147.01	60.754		
Urea	**BC patients**	105	35.09	100.399	-0.167	0.868
	Control	50	37.49	24.394		
Creatinine	**BC patients**	106	0.94	2.231	0.214	0.831
	Control	50	0.87	0.890		
Sodium	**BC patients**	96	140.25	3.121	-5.511	< 0.001
	Control	46	143.20	2.918		
Potassium	**BC patients**	96	5.63	14.339	0.853	0.396
	Control	47	4.38	0.430		
Chloride	**BC patients**	91	103.85	15.908	-0.110	0.913
	Control	47	104.10	2.172		

Biochemical parameters in patients and control were analyzed with independent Student's t-test; P<0.005 was considered a significant. Data were expressed as mean and Std.

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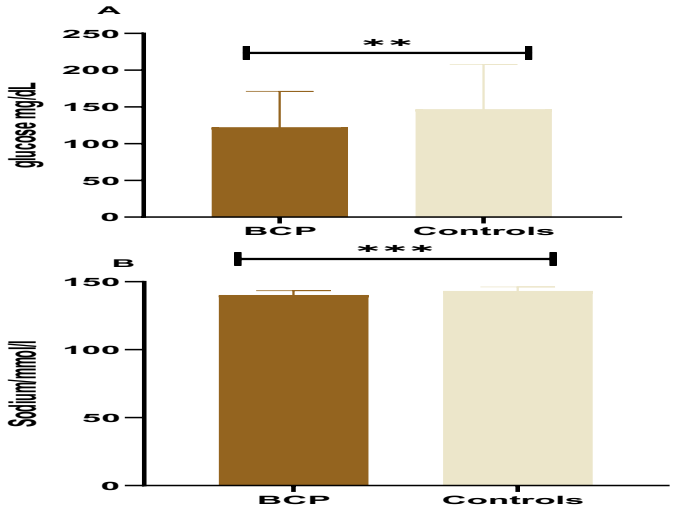

Figure 2. The bar charts illustrate the differences in the mean ±SE of glucose and potassium between healthy controls and BCP patients. (A), glucose level and B sodium level. Bars indicate mean ± SEM. ** P< 0.05 and ***P <0.001

Discussion

The mean age of breast cancer patients in this study was 49.7 ± 9.0 years, with most cases occurring between 46–55 years. This finding is consistent with reports from Libya and other Arab countries, where diagnosis commonly occurs around the late 40s to early 50s [11,12]. Such results contrast with data from Western populations, where the average age at diagnosis is typically above 60 years [13]. The relatively younger age at presentation in Arab women may reflect differences in population structure, awareness, and screening access, underscoring the need for earlier detection strategies in the region. Globally, breast cancer is generally considered a disease of older women, with incidence increasing with age [14]. A case-control study in southern Brazil reported that postmenopausal status was associated with a notably increased breast cancer risk (OR = 3.80), alongside obesity (BMI ≥ 30 kg/m²), reinforcing the role of hormonal and metabolic changes in carcinogenesis [15]. The predominance of cases among middle-aged and older women in our cohort underscores the importance of targeted screening and awareness programs for this age group. The findings of this study indicated that the majority of patients had no family history of breast cancer, yet a statistically significant difference among family history groups was observed (P < 0.001). Specifically, 65.3% of patients reported no family history of the disease, while 20.9% had a first-degree relative and 13.7% had a second-degree relative affected. Although family history was statistically significant in this cohort, the majority of patients lacked an affected relative, suggesting that most cases are non-hereditary. previous data from Libya and neighboring Arab countries, reported familial associations compared with Western populations. A study in western Libya found that 28.8% of patients had a positive family history [11], which is higher than in our cohort but still lower than rates reported in high-income countries. Variations in reporting may reflect differences in awareness, cultural attitudes toward disclosure, and the limited use of genetic screening in these settings. Furthermore, an analysis of risk factors in Benghazi suggested that family history played a minor role compared with lifestyle and reproductive factors [16].Globally, the influence of family history on breast cancer risk is well established. A large population-based study by Saadatmand et al. demonstrated that women with a first-degree relative affected by breast cancer had a 1.7–2.0-fold higher risk of developing the disease compared to those without such a history. The risk was particularly elevated when the affected relative was diagnosed before the age of 50, underscoring the importance of family history in early detection and personalized screening programs [17]. Similarly, a recent Asian meta-analysis reported a pooled odds ratio of 2.46 (95% CI: 2.03–2.97), confirming a strong familial component across populations [18]. In the present study, a significant association was observed between body mass index (BMI) and breast cancer risk (P<0.001). More than half of the cases (55.4%) were classified as obese, followed by 24.6% overweight and 20% with a normal BMI, indicating that excess body weight is a prevalent characteristic among breast cancer patients in this cohort. These findings suggest a strong correlation between obesity and an elevated risk of breast cancer, particularly among postmenopausal women. The physiological decline in estrogen levels after menopause often leads to increased adiposity and elevated BMI, both of which are established risk factors for breast cancer [19].

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Evidence from regional and international studies supports these observations [11] reported that a majority of breast cancer patients in Libya were overweight or obese, consistent with our results. Similarly, studies from Egypt and Saudi Arabia have demonstrated significant associations between high BMI and postmenopausal breast cancer risk [20, 21]. In a recent African study by Mane et al. also reported a postmenopausal rise in BMI corresponding with increased breast cancer incidence, emphasizing the regional relevance of obesity as a modifiable risk factor. These findings emphasize the importance of incorporating weight control and lifestyle modification strategies into breast cancer prevention and management programs, particularly among women at risk of or surviving breast cancer. Analysis of hematological parameters revealed significant reduction were observed in BC patients compared to controls in terms of RBC HGB, HCT, MCV and lymphocytes ($P< 0.001$). These changes may reflect both the pathophysiological effects of malignancy and the impact of therapeutic interventions [22]. Furthermore, cancer patients above 40 years have low RBC count this is correlated with immunosuppression and bone marrow suppression (BMS) [23]. Beresford et al. explained d that lower level of blood count may be as result of chemotherapy and thrombocytopenia seen in many malignancies [24]. However, platelet PLT and MCHC counts were significantly elevated in the BC groups compared to controls ($P < 0.001$), though values remained within clinically acceptable limits. Thrombocytosis in cancer patients may be driven by tumor-induced inflammatory responses or paraneoplastic syndromes and has been associated with poor prognosis in various malignancies, including breast cancer [25]. Furthermore, an increased the level of platelets has an important predictive value for the prognosis of breast cancer patients with ipsilateral supraclavicular lymph node metastasis (ISLN) metastasis, which can be used to distinguish high-risk patients as to gain clinical benefits [26].

Regarding biochemical tests, glucose was significantly lower in breast cancer patients than in controls ($P = 0.013$), while serum sodium was significantly reduced in patients; urea, creatinine, chloride, and potassium did not differ between groups. Lower glucose in cancer cohorts can reflect altered tumor glucose metabolism and increased intratumoral glucose uptake, or differences in fasting status at sampling [27,28]. Hyponatremia is a well-recognized complication in oncology, often related to paraneoplastic mechanisms, treatment effects, or systemic illness, and has been associated with worse outcomes in cancer patients [29, 30]. The absence of differences in renal markers (urea, creatinine) is consistent with other clinical series reporting largely preserved renal function at diagnosis in many breast cancer cohorts [31]. Taken together, these findings suggest that routine biochemical tests can reveal metabolic and electrolyte disturbances in breast cancer—disturbances that may reflect tumor biology or treatment effects—and support the use of basic biochemistry for patient assessment in both regional and global settings [32].

Conclusion

This study highlights key demographic, hematological, and biochemical features of breast cancer among Libyan women. Most patients were diagnosed between 46 and 66 years of age, emphasizing the predominance of breast cancer in middle-aged and older women. A significant association with obesity was observed, aligning with regional and global evidence identifying high BMI as a modifiable risk factor. Hematological changes, including reduced red cell and lymphocyte counts and elevated platelet levels, likely reflect disease-related inflammation and treatment effects. Biochemical findings revealed alterations in glucose and sodium levels, suggesting metabolic and electrolyte disturbances linked to tumor activity. Overall, these results emphasize the importance of integrating routine hematological and biochemical assessments into breast cancer management and prevention strategies in Libya. Further studies are recommended to explore genetic and metabolic factors influencing disease risk and progression.

Limitations

This study has some limitations, the main one being incomplete data for certain hematological and biochemical parameters, which may have affected the comprehensiveness of the analysis.

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Conflict of interest. NiL

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