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Research article

Hematological Profiling and Biochemical Parameters Analysis in Female Breast Cancer

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Abstract

Breast cancer is the most common cancer affecting women worldwide. It occurs when abnormal cells in the breast grow uncontrollably and form a tumor. Thirty-two serum specimens were taken from women and were divided into two groups: 15 samples from women with breast cancer and 17 from healthy women as a control group in Al-Amal Hospital for Oncology and Alnahreen center/Baghdad City, from the period March 2024 to December 2025. The results revealed that the breast cancer cases had a mean level of Hb of (12.73±0.18) compared to the healthy women (12.84±0.16) with no important variations, P=0.64. In addition, the mean levels of WBC count were (6905.26±448.33) compared to the controls (6881.76±412.34), P=0.96, and the PTL was (302.26±16.97) in comparison to the healthy females (298.23±19.03), P=0.87. Furthermore, the mean range of CRP in women with breast cancer was (2.07±0.32) compared to the control patients (1.03±0.16), with significant differences, P=0.006. While the mean range of CA15.3 was (60.45±23.50) compared to the healthy control (9.20±0.82), with an important difference, P=0.02. Moreover, the level of DHEA was elevated in breast cancer cases (278.68±33.40) in comparison to the control females, P ≤ 0.01. On the other hand, the range of CYP450 was (270.77±30.57) compared to the controls (52.84±13.35) with a highly significant differences P≤ 0.01.

Keywords: Hematological profile, Biochemical Parameters, Breast Cancer, Female

Introduction

women with breast cancer often reveals changes like elevated white blood cells (WBCs), platelets, and inflammatory markers (like NLR/PLR), alongside potential anemia (lower hemoglobin/PCV) [1], as the body responds to the cancer; these alterations, along with specific tumor biomarkers (ER, PR, HER2, CA15-3), help in diagnosis, staging, and monitoring, though results vary with cancer stage and treatment [2]. DHEA's role in breast cancer is complex: it may act as a promoter in postmenopausal women by converting to estrogen, but as a protector in premenopausal women, potentially blocking estrogen's effects, though some studies show increased risk in older premenopausal women [3]. Animal studies often show protective effects, while human studies link higher DHEA/DHEAS to increased risk in postmenopausal women, especially for hormone-receptor-positive tumors, suggesting caution with supplementation, particularly for obese or postmenopausal individuals [4]. Cytochrome P450 (CYP450) enzymes play a dual role in breast cancer: they influence cancer development by metabolizing hormones (like estrogens) and

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carcinogens, and affect treatment outcomes by breaking down chemotherapy drugs (like tamoxifen/taxanes) [5]. Evaluations focus on specific CYP genes (like CYP1A1, CYP1B1, CYP2D6, CYP2C8) and their variations (polymorphisms) to understand cancer risk, predict response to therapy, and identify potential drug resistance, with certain variations linked to poorer survival or taxane side effects, making them targets for personalized medicine [6]. CRP acts as a significant prognostic biomarker, reflecting the tumor's inflammatory microenvironment and aiding in identifying high-risk patients for personalized care, though high levels can also signal infection [7]. CA15-3 is a vital breast cancer biomarker, primarily used for monitoring treatment response, detecting recurrence, and assessing prognosis, especially in advanced stages, rather than initial diagnosis; elevated levels often signal metastatic disease (spread to liver/bones) or treatment failure [8], but levels can also rise temporarily with therapy or due to non-cancerous conditions like pregnancy/liver issues, requiring careful interpretation alongside imaging. With breast cancer [8], liver damage or spread (metastasis) even without symptoms, with elevated AST/ALT/ALP often indicating liver involvement, while lower albumin might also signal issues, helping doctors monitor cancer progression, treatment response, and liver health, though imaging (MRI/PET-CT) remains key for confirming metastases [9,10]. In women with breast cancer is crucial because cancer itself and its treatments (like chemotherapy) can impair these organs, affecting prognosis and treatment tolerance; studies show elevated liver enzymes (ALT, AST, ALP) and altered kidney markers (creatinine, urea) in patients, with liver enzyme changes often signaling metastasis or treatment toxicity, while renal issues stem from drug side effects or the cancer [11,12]. Regular monitoring using standard tests (liver panels, creatinine, GFR) helps oncologists adjust therapies and manage potential complications, with advanced imaging sometimes needed for metastasis.

Materials and Methods

Thirty-two serum specimens were taken from women and were divided into two groups: 15 samples from females with breast cancer and 17 from healthy women as a control group in Al-Amal Hospital for Oncology and Alnahreen center/Baghdad City, from the period 1st March 2024 to December 2025. The hematological aspect was performed using A CBC (Complete Blood Count) procedure involves drawing blood, usually from a vein in the arm, into a tube with anticoagulant, then analyzing it with an automated analyzer to count and measure red cells, white cells, and platelets, providing key metrics like hemoglobin and hematocrit for overall health assessment, though "biochemical aspects" usually refer to other blood tests like liver/kidney panels, while CBC focuses on cell counts and hemoglobin using automated cell counters (hematology analyzers) and sometimes manual smear review for detailed cell morphology.. Meanwhile, the biochemical and CA15.3 marker were performed using Cobas e411 Electrochemiluminescence (ECL) technology for automated immunoassays, employing principles like sandwich, competitive assays to detect various analytes (hormones, cardiac markers, etc.) from serum, plasma, or urine, with key procedural steps involving sample/reagent loading, automated analysis via ECL detection, and data interpretation through user-friendly software for reliable clinical results.

Ethical approval:

Before beginning this study, all participants provided written consent. Medical ethics approval certification, ethics committee approved the study on number 114/ 492 on January 25, 2025.

Statistical Analysis: A t-test compares group means statistically significantly, by using the t-value with the Standard Error (SE).

Results and Discussion

The prevalence of females breast cancer cases according to the age group, the ages between (30-44) yeas old was 5(33.3%) compared to the control

group 7(41.2), also the ages between (45-59) and ages >59 was 5(33.3%) compared to the control group 5(29.4%) respectively, P value=0.9, as shows in table1.

The provided data shows similar breast cancer prevalence rates across age groups (30-44, 45-59, >59) with a P-value of 0.9, indicating no statistically significant difference in rates between your case group and the control group, despite slight numerical variations, suggesting age distribution in breast cancer cases might not differ significantly from a general population sample in this specific study. Seely et al. (2024) reported that age-specific incidence rates formed a more complete picture of BC time trends with significantly increasing trends in the incidence of BC among women in their 20s, 30s, 40s, and early 50s. A greater awareness regarding the increasing number of cases of BC in women younger than 50 is critical to allow for earlier diagnosis with its resultant reduced mortality and morbidity [13].In addition, Mostafaa et al. (2023) expounded that ages ranged from 32 to 79. The maximum incidence of breast cancer 28.8% is found in women aged 50-59. The majority of examined women were married 90.8%, and 32.9% were premenopausal. Mean BMI was 26.3 ± 2.9. Among women in the study, 29% had personal or familial breast cancer history, 35.7% were regular users of oral contraceptives [14].

Table-1: Distribution of studied groups according to age range groups (years)

Parameters			Groups		Total
			Case (n=15)	Control (n=17)	
Age range (years)	(30-44)	N	5	7	12
		%	33.3	41.2	37.5
	(45-59)	N	5	5	10
		%	33.3	29.4	31.3
	>59	N	5	5	10
		%	33.3	29.4	31.3
Total		N	15	17	32
		%	100	100	100

Chi-square=0.20; P-value=0.9

In breast cancer patients, the mean hemoglobin (Hb) level was 12.73 ± 0.18 g/dL compared with 12.84 ± 0.16 g/dL in healthy women, showing no statistically significant difference (P = 0.64). Similarly, the mean white blood cell (WBC) count in patients was 6905.26 ± 448.33 cells/mm³ versus 6881.76 ± 412.34 cells/mm³ in the control group, with no significant variation observed (P = 0.96). Platelet (PLT) counts were also comparable between breast cancer cases (302.26 ± 16.97 ×10³/µL) and healthy females (298.23 ± 19.03 ×10³/µL), indicating no significant difference (P = 0.87), as shown in Table 2. These findings agreed with Abbas et al. (2024), who explained that Hb, RBCs, WBCs, neutrophils, lymphocytes, monocytes, and other parameters scored high points of evidence for BC surveillance.

Further studies are required to evaluate hematological parameter differences and biochemical parameters after or during chemotherapy or mastectomy [15]. Saadon, H. B.(2024) reviewed that there were significant differences between breast cancer women and controls because breast cancer patients showed low levels of hemoglobin, leukopenia, and thrombocytosis. This may be because chronic low-grade inflammation leads to increased levels of pro-inflammatory cytokines, which cause iron retention by the reticuloendothelial system [16].

Table 3 showed that the mean range of CRP in women with breast cancer was (2.07±0.32) compared to the control patients (1.03±0.16), with significant differences, P=0.006. While the mean range of CA15.3 was (60.45±23.50) compared to the healthy control (9.20±0.82), with an important difference, P=0.02. Moreover, the level of DHEA was elevated in breast cancer cases (278.68±33.40) in comparison to the control females, P ≤ 0.01 High significant. On the other hand, the range of CYP450 was (270.77±30.57) compared to the controls (52.84±13.35) with a highly significant differences P≤ 0.01.

Table 2: Comparison of the hematological parameters between cases and controls

Test	Groups	Mean	SE	t-test	P-value
Hb	**Case (n=15)**	12.73	0.18	0.47	0.64
	Control (n=17)	12.84	0.16		
WBC	**Case (n=15)**	6905.26	448.33	0.03	0.96
	Control (n=17)	6881.76	412.34		
Palates	**Case (n=15)**	302.26	16.97	0.15	0.87
	Control (n=17)	298.23	19.03		

SE; Std. Error Mean

Table -3: Comparison of the mean levels of CRP and CA 15.3 between cases and controls.

Test	Groups	Mean	SE	t-test	P-value
CRP	Case (n=15)	2.07	0.32	2.95	0.006
	Control (n=17)	1.03	0.16		
CA15.3	Case (n=15)	60.45	23.50	2.32	0.02
	Control (n=17)	9.20	0.82		
DHEA	Case (n=15)	278.68	33.40	7.23	≤ 0.01
	Control (n=17)	36.12	2.83		
CYP450	Case (n=15)	270.77	30.57	6.53	≤ 0.01
	Control (n=17)	52.84	13.35		

Std. Error Mean

The mean serum CRP level in women with breast cancer was 2.07 ± 0.32, compared with 1.03 ± 0.16 in the control group. This difference was statistically significant (P = 0.006), indicating an elevated inflammatory status in breast cancer patients. Hu et al. (2024) observed that BC patients with initially elevated CRP levels, specifically those with HR-positive tumors, furthermore, multivariate analysis identified CRP as an independent predictive factor for treatment response, underscoring its potential utility in clinical settings. As an inflammatory biomarker, CRP has been increasingly studied in various kinds of cancer, with evidence suggesting its association with prognosis and treatment outcomes [17,18]. Furthermore, in females with breast cancer, the mean serum level of CA15-3 was significantly higher (60.45 ± 23.50) compared with healthy controls (9.20 ± 0.82), showing a statistically significant difference (P = 0.02). a significant difference, and CA15-3 is a valuable tumor marker for monitoring breast cancer, especially when it spreads (metastasis). This marker's increase correlates with tumor size and stage, showing its utility in tracking disease progression, but it's not used for early diagnosis alone. Ibrahim et al. (2023) revealed that preoperative blood CA15-3 levels were independent predictors of prognosis in both the early and late stages of the tumor's development [19]. On the other hand, the mean serum level of DHEA was significantly elevated in women with breast cancer (278.68 ± 33.40) compared with healthy control females, with a highly significant difference (P ≤ 0.01). That statement indicates that women with breast cancer have notably higher DHEA (Dehydroepiandrosterone) levels in their blood compared to healthy women, with the average in cancer patients being around 278.68 (±33.40 units), and the difference being statistically very significant (P ≤ 0.01), suggesting DHEA levels are strongly linked to the disease, potentially influencing cancer cell growth or indicating underlying adrenal issues. Robert, T., and Chatterton, Jr. (2025) reviewed that the serum concentrations of dehydroepiandrosterone (DHEA) and its sulfated form (DS) are generally increased in breast cancer patients; serum cortisol concentrations are predictably increased as well. The association of increased adrenal steroids with breast cancer may indicate a causal role. However, administration of DHEA to rats and mice has shown a beneficial effect of DHEA in preventing or suppressing breast cancer in numerous studies [20]. In addition, in women with breast cancer, the mean level of CYP450 was significantly elevated (270.77 ± 30.57) compared with the control group (52.84 ± 13.35), showing a highly significant difference (P ≤ 0.01), because the expression of 21 cytochrome P450 (CYP) enzymes was assessed in breast tumors. The results indicated that CYP4V2, CYP4X1, and CYP4Z1 expression were correlated with a higher tumor grade. Furthermore, the absence of CYP4V2, CYP2S1, CYP3A4, and CYP26A1 was associated with better survival, although none were identified as independent prognostic factors Calaf et al., (2025) [21]. Also, Szaefer et al. (2025) proved that Cytochromes P450 (CYPs) play key roles in estrogen synthesis and catabolism, leading to potentially carcinogenic metabolites [22].

There was no significant variation in the mean level of urea in women with breast cancer (27.80±1.93) compared to the controls (27.34±2.02). Also, the mean level of Creatinine was (0.64±0.02) in comparison to the control group (0.65±0.021), as shown in Table 4.

Table-4: Comparison of the mean levels of renal function test between cases and controls

Tests	Groups	Mean	SE	t-test	P-value
Urea	Case (n=15)	27.80	1.93	0.16	0.87
	Control (n=17)	27.34	2.02		
Creatinine	Case (n=15)	0.64	0.02	0.24	0.80
	Control (n=17)	0.65	0.021		

There was no significant difference in the mean serum urea levels between women with breast cancer (27.80 ± 1.93) and the control group (27.34 ± 2.02). Similarly, the mean creatinine level in breast cancer patients (0.64 ± 0.02) was comparable to that of the control group (0.65 ± 0.021), indicating no significant variation between the two groups. The provided data shows thatSerum urea (27.80 vs. 27.34) and creatinine (0.64 vs. 0.65) levels are nearly identical between women with breast cancer and healthy controls, suggesting these specific kidney function markers don't significantly differ in early breast cancer and aren't useful for diagnosing or monitoring its progression at this stage, though some studies note levels might change after treatment like chemotherapy. Raza et al. (2025) proved that there was a significant increase in blood urea and creatinine levels after the treatment as compared to before the start of therapy [23]. In addition, Al-Saeedi et al.(2023) reported that urea and creatinine showed a significant increase in the serum of G2compared to G1 and healthy women [24].

With the liver function group in breast cancer females ALP level in breast cancer females was (59.53±4.77) compared to the healthy control (61.11±3.93), with no important variation, P=0.79, but the mean level of ALT was (15.12±2) compared to the controls (16±1.99), P=0.75. While AST was non- significant too (14.65±2.02), the controls were (16±1.89), P=0.95. On the other hand Bilirubin level was(0.54±0.05) in the control group (0.53±0.06), a non-significant variation, P=0.92, as shown in Table 5.

Table-5: Comparison of the mean levels of liver function test between cases and controls

Tests	Groups	Mean	SE	t-test	P-value
ALP	Case (n=15)	59.53	4.77	0.25	0.79
	Control (n=17)	61.11	3.93		
ALT	Case (n=15)	15.12	2	0.30	0.75
	Control (n=17)	16	1.99		
AST	Case (n=15)	14.65	2.02	0.48	0.62
	Control (n=17)	16	1.89		
Bilirubin	Case (n=15)	0.53	0.06	0.98	0.92
	Control (n=17)	0.54	0.05		

Regarding liver function parameters, the mean ALP level in women with breast cancer was (59.53 ± 4.77), compared with (61.11 ± 3.93) in the healthy control group, with no statistically significant difference (P = 0.79). This statement indicates that while women with breast cancer had slightly lower mean ALP levels (59.53 ± 4.77) than healthy women (61.11 ± 3.93), the difference wasn't statistically significant (P=0.79), suggesting ALP levels might not be a primary indicator of liver involvement in this specific group, but other studies show ALP can rise significantly with bone or liver metastases, highlighting ALP's complexity as a biomarker and the need for broader liver function tests (LFTs) for accurate monitoring. Singh et al. (2023) explained that Variations in serum levels of biochemical

parameters, especially alkaline phosphatase (ALP) changes, may be of great help in the diagnosis of breast carcinoma [25]. On the other hand "mean level of ALT was (15.12±2) confronted to the controls (16±1.99), P=0.75," indicates that while there's a tiny difference in ALT (liver enzyme) levels between breast cancer patients and controls, the result is not statistically significant (P > 0.05), meaning any observed difference is likely due to random chance, not the cancer itself, suggesting ALT is not a reliable marker in this specific comparison. These results agreed with (Altimmime, et al. 2023) who revealed that none of the median levels of ALP, ALT, or AST in the newly diagnosed breast cancer group demonstrated a significant difference from the non-metastatic breast cancer group (ALP 63.70 vs 64.60 U/L; p>0.9999) (ALT 14.80 vs 15.60 U/L; p>0.9999) (AST 18.00 vs 18.20 U/L; p>0.9999) [26]. Also, Leser (2023) reviewed that Liver function protein levels should be considered as potential indicators when screening for liver metastasis in patients with breast cancer [27]. Moreover, this study snippet shows that breast cancer patients and control subjects had nearly identical mean bilirubin levels (0.54 vs. 0.53 mg/dL), with a P-value of 0.92 indicating no statistically significant difference, meaning the slight variation is likely due to chance, suggesting bilirubin isn't a reliable indicator of breast cancer status in this specific comparison. While some studies link bilirubin to cancer risk or prognosis, these results suggest that at these levels, it doesn't differentiate breast cancer patients from healthy individuals, highlighting the need for more research into bilirubin's complex role. But these results disagreed with (Khoei et al., 2023) who reported that evidence from experimental studies suggests that bilirubin, a metabolic by-product of hemoglobin breakdown, has anticancer activity and may, therefore, reduce the risk of gastrointestinal (GI) cancers [28].

Table 6 illustrates that with breast cancer women, there was a direct correlation between CRP with CA15.3 (r= .03), with DHEA (r= .289), and with P450 (r=.479**), with significant variations in P-value (.867, .109, .006) respectively. On the other hand, there was a direct correlation between CA15.3 with CRP (r=.867) and with DHEA (r= .409*) and with P450 (r= .232), with important differences, P-value (.867, .020, .202) respectively. Moreover, a direct correlation between DHEA and CRP (r= .289) and with CA15.3 (r=.409*) and with P450 (r=.679**), with higher important variations, P-value (.109, .020, .000) respectively. Finally there was direct correlation between P450 with CRP (r= .479**) and with CA15.3 (r=.232) and with DHEA (r=.679**) with higher important variations, P-value (.006, .202, .000) respectively.

Table 6: Correlation analysis between studied parameters

Parameters		CRP	CA15.3	DHEA	P450
CRP	r	1	.031	.289	.479**
	P-value		.867	.109	.006
CA15.3	r	.031	1	.409*	.232
	P-value	.867		.020	.202
DHEA	r	.289	.409*	1	.679**
	P-value	.109	.020		.000
P450	r	.479**	.232	.679**	1
	P-value	.006	.202	.000	
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

In women with breast cancer, correlation analysis revealed several significant associations among CRP, CA15.3, DHEA, and cytochrome P450. CRP showed a weak positive correlation with CA15.3 ($r = 0.03$, $p = 0.867$) and a moderate positive correlation with DHEA ($r = 0.289$, $p = 0.109$); however, neither association was statistically significant. In contrast, CRP demonstrated a significant positive correlation with P450 ($r = 0.479$, $p = 0.006$). CA15.3 exhibited a strong positive correlation with CRP ($r = 0.867$, $p = 0.867$), although this relationship was not statistically significant. A significant moderate positive correlation was observed between CA15.3 and DHEA ($r = 0.409$, $p = 0.020$), while the correlation between CA15.3 and P450 was weak and not significant ($r = 0.232$, $p = 0.202$). DHEA showed a moderate positive correlation with CRP ($r = 0.289$, $p = 0.109$), which was not statistically significant. However, DHEA correlated significantly with CA15.3 ($r = 0.409$, $p = 0.020$) and demonstrated a strong, highly significant positive correlation with P450 ($r = 0.679$, $p < 0.001$). Finally, P450 displayed a significant positive correlation with CRP ($r = 0.479$, $p = 0.006$) and a strong, highly significant correlation with DHEA ($r = 0.679$, $p < 0.001$), whereas its correlation with CA15.3 was weak and not statistically significant ($r = 0.232$, $p = 0.202$). In this breast cancer study, CRP showed significant positive links with P450, while CA15.3 linked significantly with DHEA, and DHEA strongly linked with P450, but many other correlations, like CRP-CA15.3 and CA15.3-P450, were weak or not statistically significant despite initial strong correlation numbers, highlighting that statistical significance (p-value) is crucial for interpreting these biomarker relationships in breast cancer and these findings was matched with Sulaiman, et al. (2022) [29].

Conclusions:

The results concluded that there were highly significant statistical differences in CRP, CA15.3, DHEA, and P450 levels between breast cancer females compared to the control group, and there was some increase in the count of lymphocytes (white blood cells).

Conflict of interest: NIL

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