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Study of Some Biochemical Alterations in Breast Cancer Patients

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ABSTRACT

Breast cancer persists as a major international medical challenge because it stands as one of the prominent causes of female cancer-related mortality. The research based on the Kurdistan Region of Iraq investigates breast cancer patients' biochemical and metabolic transformations regarding liver, renal, and lipid functions. The investigation included sixty breast cancer patients and forty subjects within the control group as part of a case-control study. Biochemical assessment determined random blood sugar (RBS), lipid profile, and indicators that measured liver and kidney function. Evidence shows that breast cancer patients have major psychological changes that lead to heightened anxiety and despair, and show higher body mass index metrics than patients without breast cancer. Multiple research studies indicate that breast cancer exists as a measurable link to the combined presence of past miscarriage and familial tendencies for cancer development. Total cholesterol measurements combined with triglyceride levels and LDL quantities increased in patients with dyslipidemia and showed lower HDL values. Blood glucose levels increased in breast cancer patients during the research period. Renal patients had higher blood urea, elevated serum creatinine levels, and increased AST, ALT, and ALP liver enzyme activity. Still, their total bilirubin and direct and indirect bilirubin decreased. Studies underline the importance of metabolic health monitoring among breast cancer patients because detected changes in assessments can affect treatment response, with disease management. The study proves that breast cancer needs individualized care strategies that integrate metabolic care with psychological interventions, while showing important information about cancer's advanced metabolic processes.

Keywords: Breast cancer, lipid profile, renal function, liver function, metabolic alterations.

INTRODUCTION

Breast cancer surpasses every other malignancy in worldwide mortality rates among females, which establishes it as a major international health issue. The disease's natural difficulty alongside its unpredictable behavior remains a major obstacle to achieving positive results for patients (Kim *et al*., 2025). Targeted care for breast cancer requires better knowledge of its molecular development mechanisms because the condition shows different symptoms and follows unpredictable trajectories without a predictable reaction to available therapies. In this context, identifying and characterizing key metabolic and biochemical alterations are crucial because they can help us understand the illness better, make better predictions, and provide more focused and individualized treatments *(Salam et al*., 2023).

Cancer cells generally exhibit a remarkable phenomenon known as metabolic reprogramming, which supports the unique demands of malignant growth, including uncontrolled cell proliferation, resistance to cell death, and the ability to invade and metastasize to distant sites. This phenomenon is known as the Warburg effect, and it occurs in cancer cells because, in oxygen-rich environments, glycolysis is still preferred over oxidative phosphorylation, the standard mechanism by which cells produce energy (Finley, 2023). This metabolic adaptation enables cancer cells to rapidly generate the essential building blocks for growth and division while producing energy. However, metabolic reprogramming in cancer extends beyond glucose metabolism, encompassing a wide range of biochemical processes (Yang *et al*., 2023).

The process of lipid metabolism plays a crucial and multifaceted role in advancing breast cancer growth. Cell membranes derive from lipids, while these molecules serve as signaling compounds and energy storage for substantial reserves. Modifying lipid metabolism produces broad-ranging effects on cancer advancement by altering membrane properties, receptor signals, cell growth patterns, survival capacity, and treatment outcomes (Martin-Perez *et al*., 2022). Metabolic lipid abnormalities create an inflammatory state, thus helping tumors expand in size and disseminate across the body. The condition dyslipidemia, manifesting as abnormal circulating lipid levels, exists frequently among patients who have breast cancer. The abnormal lipid composition shows modifications of tumor metabolic behavior while also posing threats to organ functionality across the body (Zimbalist *et al*., 2022).

The liver and the kidneys function as a fundamental metabolic organ that controls body equilibrium. The liver functions as a primary metabolic center because it regulates protein production and toxin elimination, controls the operational processes of glucose and lipid metabolism, and synthesizes proteins. The body mainly depends on organ functions for drug metabolism and processing (Cao *et al*., 2022). The liver function of patients with breast cancer becomes compromised when they experience systemic inflammation and develop treatment-related toxicities or when metastasis occurs, because this alters both prognosis along treatment tolerance and therapeutic effectiveness (Liu *et al*., 2025).

The filtration system of the kidneys among breast cancer patients can become impaired because these organs must eliminate waste substances and control blood pressure, as well as maintain fluid and electrolyte equilibrium. Nephrotoxicity from particular oncology treatments and medical complications makes renal dysfunction more likely than direct tumor involvement in the kidneys. A bad kidney condition results in lower survival rates, greater medication toxic reactions, and increased toxic substance build-up in the body (Thapa *et al*., 2023).

The objective of this research is to analyze all metabolic and biochemical changes involving breast cancer while prioritizing the study of lipid metabolism, together with liver functionality and kidney function. The research specifically analyses breast cancer patients located within Erbil and Sulaymaniyah cities that belong to the Kurdistan Region of Iraq.

The investigation uses lipid profile analysis combined with liver and renal function marker evaluation to develop better knowledge of breast cancer's multifaceted metabolic patterns. This research investigation will enable the identification of new therapeutic goals and the development

of enhanced approaches to battle metabolic issues in breast cancer patients, leading to better clinical results.

MATERIALS and METHODS

Study population and design

The investigation through this case-control study describes metabolic and biochemical modifications in breast cancer. The investigators recruited female participants from Erbil and Sulaymaniyah between 18 and 70 years old for this study.

Group A, the case group, contains sixty women who received a breast cancer diagnosis through pathologic examination.

Group B participants consisted of 40 healthy female subjects who did not have a cancer history. The research occurs within the healthcare institutions of Hiwa Hospital and Shoresh Hospital in Sulaymaniyah, Nanakaly Hospital, Rizgary Public Hospital, and Balsam Private Hospital in Erbil.

Collection of blood samples

Venous blood samples (5 mL) were collected from each participant under aseptic conditions. Put for 15 min at room temperature, centrifuge, and the separated serum was stored at -80°C until further analysis. Biochemical tests-including random blood sugar (RBS), lipid profile (cholesterol, triglycerides, LDL, HDL), renal function tests (urea, creatinine), and liver function tests (AST, ALT, ALP, total serum bilirubin, direct bilirubin, and indirect bilirubin)-were performed for both groups: Breast cancer patients and healthy controls.

Assessment of metabolic and biochemical alterations

Metabolic and biochemical changes were evaluated by measuring the following:

- Lipid profile, including cholesterol, triglycerides, LDL, and HDL.
- Markers of renal function, including creatinine and urea.
- Liver function indicators, including AST, ALT, ALP, total bilirubin, direct bilirubin, and indirect bilirubin.

Inclusion and exclusion criteria

Exclusion criteria were as follows: Males, individuals younger than 18 or older than 77, pregnancy or breastfeeding, chronic inflammatory or autoimmune conditions, previous malignancies, abnormal laboratory results in the control group suggesting potential health issues, breast cancer patients receiving chemotherapy or radiation, benign breast lesions, hemolyzed blood samples, alcohol consumption, hormone therapy, chronic medical conditions requiring treatment, incomplete investigations resulting in unknown stage or lymph node status, other types of breast carcinoma (such as sarcoma, adenocarcinoma, or recurrent breast cancer), and failure to complete the treatment plan for the post-treatment group.

Study timeline

The study, which started on September 25, 2024, spanned six months, concluding on March 20, 2025. The timeline involved collecting patient information and preparing samples for biochemical analysis, followed by result analysis and interpretation, and finally, writing and submitting the report.

Statistical analysis

All statistical procedures ran on SPSS version 25.0 created the analytic results. Non-continuous variables are presented by percentage and frequency distribution or mean ± standard deviation (SD). This study employed the Shapiro-Wilk test to verify all data distribution properties. The data that did not follow a normal distribution was tested using Mann-Whitney U, while data that did fit the normal distribution were tested using independent t-tests. A statistical evaluation of biochemical marker interrelationships occurred using Spearman's or Pearson's correlation coefficients. A multivariate regression technique helped evaluate how accurately the selected indicators function as outcome predictors. The research considered a p-value below 0.05 as statistically significant.

Questionnaire form design

The standardized questionnaire required participants to furnish thorough information. The demographic section contained questions to determine participant age values, along with BMI assessments, smoking habit verifications, and breast cancer family history records. Medical history acquisition included the collection of information about menopausal status, together with comorbidities and medication usage. A supplementary set of questions about both disease stage and treatment background was collected specifically from Group A patients with breast cancer. Physical activity and dietary habits of participants were examined using the questionnaire to determine their effects on disease advancement and biomarker measurements. The team received approval on the questionnaire from subject-matter experts before running a pilot test phase.

Ethical considerations

Hawler Medical University authorized the study execution while participants received written consent for research participation. All procedures maintained the ethical standards specified in the declaration of Helsinki (2013) by creating anonymous data records and establishing strict confidentiality measures for participant information. The researchers verbally acquired participant consent before starting the study while granting them free consent to exit at any point without receiving penalties throughout the process. The blood sampling study carried low risks because it included only regular laboratory blood tests.

RESULTS AND DISCUSSION

The research examined breast cancer metabolic and biochemical transformations affecting women from Erbil and Sulaymaniyah residential areas in the Iraqi Kurdistan Region through studies of lipid abnormalities as well as liver and kidney impairment. Findings demonstrated significant metabolic disorders linked to the disease because they revealed comprehensive differences between breast cancer patients and the general population. Research data confirms in detail that breast cancer develops from a combination of various factors, which agrees directly with current studies and past research.

The clinical records revealed that breast cancer patients exhibited a weight measurement average that exceeded that of the control participants, which supports many studies linking obesity to elevated breast cancer susceptibility. Patients with breast cancer described higher emotional distress, which manifested as excessive worry and despair, between the groups, demonstrating a direct effect of the disease on wellness. The research implies that mental health issues influence the risk of starting or progressing with breast cancer.

All participants received their clinical history evaluation through questionnaires, except the BMI measurement, which required a numerical calculation. (Table 1).

Table 1: Clinical history of the study population.

Variables			Control Group	B.C group	t-test	p-value
BMI (Kg/M^2)		**Mean± SD**	25.60±4.71	32.04±4.55	6.78	< 0.001*
					Chi-Square	**p-value**
Emotional change	yes	*n* (%)	4 (10.0)	60 (100.0)	84.37	< 0.001*
	no		36 (90.0)	0 (0.00)		
First menstruation age < 12 years	yes		5(12.5)	17 (28.3)	3.50	0.06 NS
	no		35 (87.5)	43 (71.7)		
Previous miscarriage	yes		8 (33.3)	28(87.5)	17.52	< 0.001*
	no		16 (66.7)	4(12.5)		
Menopause age <55	yes		3(7.5)	8 (13.3)	0.83	0.36 NS
	no		37 (92.5)	52(86.7)		
Family history of cancer	yes		10 (25.0)	47(78.3)	27.85	< 0.001*
	no		30 (75.0)	13(21.7)		
					Fisher's Exact	**p value**
Had pregnancies	yes		22(91.7)	28(87.5)	---	0.61 NS
	no		2(8.3)	4(12.5)		

NS: Non- significant correlation, * significant correlation, *n:* Frequency.

(Table 1) shows that body mass index (BMI) represented one of the most important study outcomes because both groups displayed significant BMI discrepancies. The BMI measurements indicated a substantial difference between groups, with BC patients' BMI reading at 32.04 ± 4.55 kg/m², whereas the control patients had a BMI of 25.60 ± 4.71 kg/m² ($p<0.001$). The statistically valid data indicate that obesity plays a key part in fostering breast cancer occurrence and disease progression. (Park *et al*., 2021) state that adipose tissue-derived estrogen is a primary factor in hormone-sensitive tumor growth. The research findings strengthen the concept that greater body fat amounts create an environment that promotes breast cancer development. Specify the emotional change of subjects shown in Fig. (1).

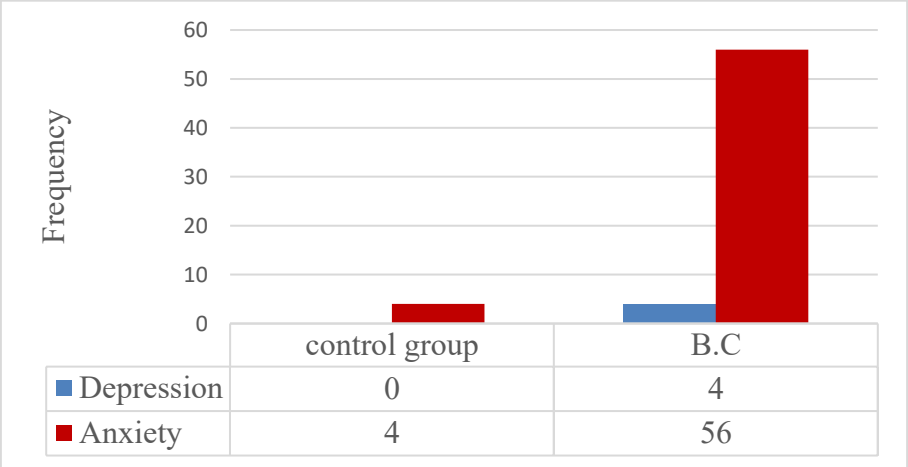

Fig. 1: Breast cancer subjects present with depression and anxiety by 66.7% and 93.33% respectively, whereas only 10% of the healthy control group present with anxiety.

Research results revealed substantial emotional health differences based on the substantial psychological gap between patient groups. All breast cancer patients experienced emotional disturbances at a rate of 100% according to Fig. (1). In comparison, depression symptoms reached 66.7% and anxiety symptoms affected 93.33% of the patients, but only 10% of healthy controls reported emotional changes ($p<0.001$). The study results match existing evidence from (Chen *et al*., 2023) to demonstrate how chronic stress and faulty cortisol mechanisms regulate immune defenses and promote tumor development. The connection between emotional suffering in BC patients extends beyond diagnostic-related effects toward an influence on disease progression and development, which makes psychological screenings and support possible intervention opportunities.

The analysis of reproductive history produced clear differences between the two study groups. Early menarche, which occurs before 12 years, affected 28.3% of BC patients, whereas only 12.5% of controls experienced this, but statistical significance amounted to $p=0.06$. The analysis indicated a significant difference between groups since BC patients experienced miscarriage at 87.5% compared to 33.3% in controls ($p<0.001$). (Kalia, 2022; Lai *et al*., 2022) conducted research that supports the connection between extended estrogen exposure and altered hormonal patterns and their link to BC risk. The disrupted hormones during miscarriage might impact breast tissue cancer susceptibility through their effect on breast cell malignant transformation.

The occurrence of cancer within family members proved significantly higher among breast cancer patients at 78.3% compared to controls who had 25% ($p<0.001$), thus indicating strong genetic and environmental risk factors. Fig. (2) depicts familial relationships of BC patients, which shows elevated occurrence of breast cancer within direct family lines such as mother-daughter and sibling, along with associations to leukemia and other cancers, including colon, uterine, and lung. The results strengthen existing research by (Torres-de la Roche *et al*., 2023) regarding how hormones and genetics influence cancer susceptibility. Research confirms the essential role of

family cancer screening combined with genetic counseling for people belonging to high-risk groups.

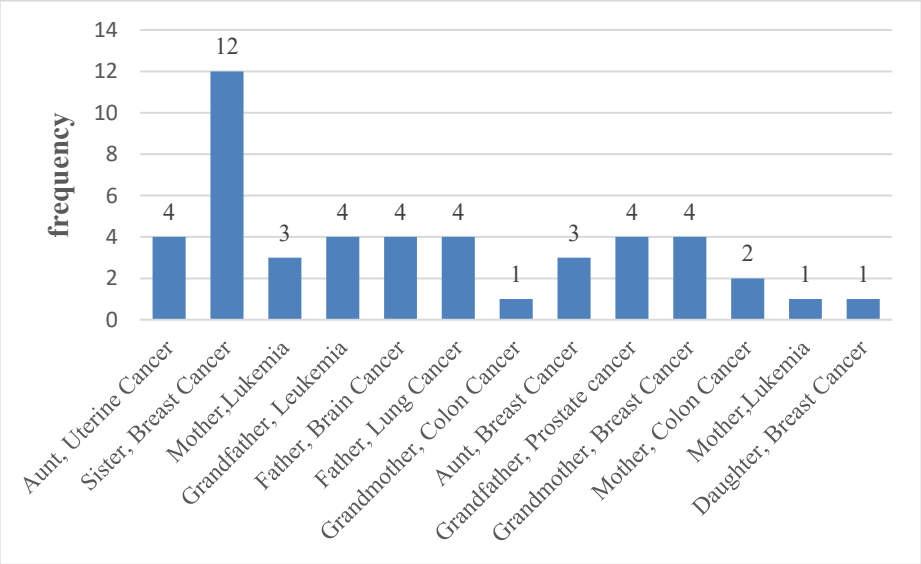

Fig. 2: Relationship and types of cancer history for all patients who have a family history of cancer.

The biochemical testing of metabolic factors established substantial changes to glucose and lipid levels in BC patients. The results in (Table 2) confirm that BC patients displayed elevated fasting blood glucose levels, measuring at 132.49 ± 37.81 mg/dL compared to control subjects at 104.20 ± 15.48 mg/dL ($p<0.001$), which supports metabolic dysregulation in tumor development. Tumor development and cancer metabolic remodeling are proven by (Liang *et al*., 2024; Li *et al*., 2024) to be enhanced by high blood glucose levels, especially in triple-negative breast cancer (TNBC) patient populations. The results emphasize the need to measure blood glucose control because it represents a predictive condition and treatment objective for BC patients.

Table 2: Comparison of blood glucose and lipid profile parameters between the control group and the breast cancer group.

Variables		Control group	B.C group	t	p-value
Blood glucose (mg/dl)	Mean ± SD	104.20±15.48	132.49±37.81	4.48	< 0.001*
Cholesterol (mg/dl)		139.43±32.45	178.87±55.45	4.05	< 0.001*
Tri glyceride (mg/dl)		84.96±31.76	173.98±69.50	7.58	< 0.001*
HDL (mg/dl)		50.28±13.48	33.20±10.06	- 67.21	< 0.001*
LDL (mg/dl)		96.79±30.19	124.67±38.74	3.83	< 0.001*

* Significant difference

Metabolic conditions were uncovered by evaluating the study participants' lipid profiles. BC patients exhibited significantly elevated cholesterol measurements of 178.87 ± 55.45 mg/dL. At the same time, their triglyceride levels surged to 173.98 ± 69.50 mg/dL and their LDL values rose to 124.67 ± 38.74 mg/dL when compared to 139.43 ± 32.45 mg/dL, 84.96 ± 31.76 mg/dL, and 96.79 ± 30.19 mg/dL, respectively ($p<0.001$). Additionally, their HDL decreased to 33.20 ± 10.06 mg/dL (p Entire metabolic function analysis showed BC patients having a 104.77% triglyceride level increase combined with a 33.96% decrease in HDL levels. Test results by (Wu *et al*., 2024; Zhang *et al*., 2024;

(Sawada *et al*., 2023) show that cancer progression links to lipid imbalances, especially HDL dysfunction. The disease progression of tumors receives additional support from LDL research,

which shows an increased receptor expression according to (Feldt *et al*., 2020), reinforcing the metabolic nature of breast cancer.

Table 3: Comparison of liver function and kidney function parameters between the control group and the breast cancer group.

Variables		Control group	B.C group	t	p-value
AST (U/L)	Mean ± SD	18.97±5.34	25.94±7.86	4.89	< 0.001*
ALT (U/L)		15.15±5.84	22.32±9.62	4.21	< 0.001*
ALP (U/L)		70.52±19.69	84.05±21.90	3.21	0.002*
Total bilirubin (mg/dl)		0.45±0.25	0.25±0.12	-5.28	< 0.001*
Direct bilirubin (mg/dl)		0.14±0.077	0.10±0.06	- 2.47	0.012*
Indirect bilirubin (mg/dl)		0.31±0.19	0.14±0.08	- 5.79	< 0.001*
Blood urea (mg/dl)		25.61±6.79	35.92±6.96	7.36	< 0.001*
S. Creatinine (mg/dl)		0.54±0.12	0.85±0.19	8.81	< 0.001*

* Significant difference

Liver tests assessed AST levels at 25.94 ± 7.86 U/L, ALT levels at 22.32 ± 9.62 U/L, and ALP at 84.05 ± 21.90 U/L in BC patients compared to controls, who had AST levels at 18.97 ± 5.34 U/L, ALT levels at 15.15 ± 5.84 U/L, and ALP levels at 70.52 ± 19.69 U/L. These clinical results (AST $p<0.001$, ALT $p<0.001$, and ALP $p=0.002$) indicate that hepatic stress could occur because of subclinical liver infection, systemic inflammation, or treatment-associated toxicity. The study by (Leser *et al*., 2023) demonstrated elevated AST levels in patients with liver metastasis, alongside findings from (Chen *et al*., 2023; Chen *et al*., 2025), which focused on using liver enzyme ratio changes for prognosis. The bone-turnover marker ALP helps identify early bone involvement, according to (Jiang *et al*., 2023; Tayubi and Madar, 2022) When bone metastases are determined.

BC patients displayed markedly reduced total, direct, and indirect bilirubin levels, which decreased by 44.44%, 28.57%, and 54.83%, respectively. The observed pattern contrasts with typical bilirubin-fatigue assessments, even though liver dysfunction is normally associated with hyperbilirubinemia, yet it confirms (Hu *et al*., 2024). The protective antioxidant properties of bilirubin might explain why decreased bilirubin levels are linked to BC risk. Cancer patients typically have exhausted antioxidant reserves that lead to elevated oxidative stress and conditions supportive of tumor growth.

The patients with BC presented significantly raised levels of renal markers, urea and creatinine. The patients in the BC group exhibited urea levels of 35.92 ± 6.96 mg/dL, which exceeded those of controls, 25.61 ± 6.79 mg/dL, while creatinine levels reached 0.85 ± 0.19 mg/dL from 0.54 ± 0.12 mg/dL ($p<0.001$ for both). The elevated markers can show signs of kidney deterioration at the beginning stage or be a result of medication toxicity or muscular damage. The findings of (Altundag, 2023; Cavdar *et al*., 2024) link creatinine fluctuations to altered pharmacokinetic profiles of tamoxifen breast cancer medications when patient clearance becomes lowered.

The completed research encompasses the mounting scientific agreement that breast cancer develops because of multiple interacting forces between hormones and metabolism, together with emotional and hereditary components. Global research findings about this subject validate the credibility of this study's conclusion. The collected data between emotional, metabolic, hepatic, and renal patterns demonstrates the requirement for extensive screening and management strategies that involve multiple healthcare specialists. The research evidence emphasizes the need for early detection and the possibility of using risk elements, including blood glucose control and lipids, weight management, and emotional health, in holistic breast cancer prevention and treatment strategies.

CONCLUSIONS

This paper thoroughly analyzes the metabolic and biochemical abnormalities in breast cancer patients during the reformulation of lipid, liver, and renal failure. Statistical analysis establishes distinct patterns that separate breast cancer patients from healthy subjects based on BMI value, mental state indicators, blood lipid measurements, blood sugar outcomes and liver and kidney diagnostic markers. These research results demonstrate breast cancer's complex metabolic reprogramming, thus indicating why healthcare professionals might need to monitor the metabolic health status of breast cancer patients. Breast cancer patients with high blood glucose combined with dyslipidemia, along with reduced liver and kidney function, indicate a strong association between metabolic dysfunction and disease development and treatment outcomes.

The study adds to the mounting data connecting metabolic disorders to cancer and points directions for next studies meant to enhance early identification, treatment plans, and patient outcomes. More research is required to grasp the processes better, causing these metabolic and biochemical alterations, especially the involvement of dyslipidemia, raised liver enzymes, and lowered bilirubin levels in breast cancer development, in driving changes. Investigating the possible therapeutic advantages of focusing on metabolic routes, including glycolysis and lipid metabolism, might help to create more successful therapy plans. Future studies might also concentrate on finding fresh therapy targets and creating individualized strategies to control metabolic problems in breast cancer patients, thereby enhancing their quality of life and survival chances.

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دراسة بعض التغيرات الكيميائية الحيوية لدى مرضى سرطان الثدي

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الملخص

لا يزال سرطان الثدي يشكل مصدر قلق صحي عالمي رئيسي، ويعد من بين الأسباب الرئيسية للوفيات المرتبطة بالسرطان بين النساء. تركز هذه الدراسة على التحولات الأيضية والكيميائية الحيوية لدى مرضى سرطان الثدي من إقليم كردستان العراق، مع التركيز على اختلال وظائف الدهون والكبد والكلى. شملت دراسة الحالات والشواهد هذه أربعين من الأفراد الأصحاء كمجموعة ضابطة وستين مريضًا مصابًا بسرطان الثدي. تم تقييم سكر الدم العشوائي (RBS)، وملف الدهون، ومؤشرات وظائف الكبد والكلى باستخدام الاختبارات الكيميائية الحيوية. بالإضافة إلى التغيرات النفسية كشفت النتائج أن مرضى سرطان الثدي لديهم مؤشر كتلة جسم (BMI) أعلى من المجموعة الضابطة. ارتبط سرطان الثدي بشكل كبير بتاريخ من الإجهاض وتاريخ عائلي للإصابة بالسرطان. أظهر المرضى اضطرابًا في شحوم الدم من خلال إظهار مستويات أعلى من الكوليسترول الكلي والدهون الثلاثية والبروتين الدهني منخفض الكثافة (LDL) إلى جانب قيم منخفضة من البروتين الدهني عالي الكثافة (HDL). علاوة على ذلك، كانت مستويات سكر الدم أعلى بشكل ملحوظ لدى مرضى سرطان الثدي. بالإضافة إلى ذلك، ارتفعت مؤشرات وظائف الكلى (يوريا الدم، الكرياتينين في الدم) وإنزيمات الكبد (AST، ALT، ALP)، لكن مستويات البيليروبين الكلي والمباشر وغير المباشر كانت منخفضة. تشير النتائج إلى أن إعادة البرمجة الأيضية الكبيرة التي تشمل اضطراب شحوم الدم، وارتفاع سكر الدم، وانخفاض وظائف الكبد والكلى مرتبطة بسرطان الثدي. نظرًا لأن هذه التغييرات قد تؤثر على تطور المرض ونتائج العلاج، تؤكد الدراسة على ضرورة تتبع وإدارة الصحة الأيضية لدى مرضى سرطان الثدي. تسلط النتائج الضوء على الحاجة إلى خطط علاجية مخصصة تأخذ في الاعتبار العوامل الأيضية والنفسية معًا، كما توفر تحليلًا عميقًا للمشهد الأيضي لسرطان الثدي.

الكلمات الدالة: سرطان الثدي، صورة الدهون، وظائف الكلى، وظائف الكبد، تحولات أيضية.