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COMPARATIVE ANALYSIS OF HEMATOLOGICAL AND BIOCHEMICAL PROFILE CHANGES IN PRE & POST-CHEMOTHERAPY OF BREAST AND OVARIAN CANCER PATIENTS

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Abstract

This study focused on 194 female cancer patients who received chemotherapy from July 2018 to December 2022. The median age of the population was 59.5 years. Among these patients, those diagnosed with ovarian cancer had a mean age that was 33% older than 50 years, and breast cancer patients had a mean age that was 37.5% older than 49. The presence of healthcare disparities was underscored by the observation that 70% of individuals diagnosed with ovarian cancer belonged to the most economically disadvantaged social stratum, and delayed onset of menstruation increased the likelihood of developing malignant tumours. Chemotherapy caused significant changes in haematological profiles. The levels of haemoglobin (11.59 ± 1.31 to 11.35 ± 1.42 g/dL), platelets (2.82 ± 1.17 to 2.73 ± 1.10 x10^3/µL), and RBC (4.29 ± 0.52 ± 0.52 x 0.59 x 0.1) µl/6.1 var µ1. all decreased in breast cancer patients compared to ovarian cancer patients. Alkaline phosphate levels were reduced in patients with ovarian cancer, suggesting that chemotherapy caused changes in liver and bone metabolism. On the other hand, breast cancer patients with lower levels of SGPT and total bilirubin had healthier liver function. Both the haematological and biochemical profiles showed positive skewness and kurtosis analysis. This means that the concentrations of bilirubin, SGPT, SGOT, and alkaline phosphate were higher at the upper end. Specifically, bilirubin had a skewness of 1.5 and kurtosis of 3.9, SGPT had a skewness of 1.1 and kurtosis of 2.8, SGOT had a skewness of 1.3 and kurtosis of 3.2, and alkaline phosphatase had a skewness of 1.2 and 3.5 kurtosis. Correlation analysis revealed significant relationships between many parameters, especially between mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) in ovarian cancer patients, both before ($r=0.65$, $p<0.01$) and after ($r=0.62$, $p < 0.01$) therapy. reliability study using Cronbach's alpha coefficients showed that MCV had a high level of reliability ($\alpha = 0.721$) among the haematological parameters. In general, both the biochemical ($\alpha = 0.658$) and haematological ($\alpha = 0.662$) profiles showed good reliability. Several factors influence the outcome of chemotherapy, underscoring the need for personalized treatment and vigilant monitoring to improve patient care.

Keywords- Ovarian Cancer; Breast cancer; Chemotherapy; Hematological profiles; Biochemical profiles

Introduction

Cancer is characterized by unregulated cell growth and is a significant global health issue [1]. Among the different types of cancer that affect both sexes, breast and ovarian cancer are more common in women [2]. These malignancies incur significant costs; according to GLOBOCAN (2020), breast cancer is the most common disease, and Cancer Research UK (2022) states that ovarian cancer contributes significantly to the total number of women who die from cancer in the world. The management of ovarian and breast cancer remains complex, despite advances in screening, diagnosis and treatment. Chemotherapy is a crucial therapeutic choice in these cases [3].

The multiple clinical presentations and genetic subgroups of breast cancer present challenges for early detection and effective therapy [4]. The development of cancer is determined by several variables, such as lifestyle choices, hormonal effects, genetic predisposition and environmental exposure [5, 6]. These elements emphasize the intricate interplay between genetic and environmental factors in the formation of cancer. Despite the improvement in early detection rates and subsequent increase in survival benefits due to screening programs [7], the treatment of advanced and metastatic cancer remains a challenging problem.

Breast cancer is a complex disease with multiple molecular subtypes arising from the interaction of hormones, environmental factors and genetic predisposition [8]. Genes responsible for the development of tumors include TP53 [9], BRCA1 [10], BRCA2 [11] and HER2/neu [12]. Abnormal protein expression that promotes the development of tumors includes progesterone receptor (PR) [13], estrogen receptor (ER) [14], human epidermal growth factor receptor 2 (HER2) and progesterone receptor (ER) [15]. The need for a more comprehensive understanding of genetic and protein alterations in disease development is emphasized by the persistent challenges in managing treatment resistance and combating aggressive subtypes despite the advances in molecular profiling and targeted therapy [16].

The process of diagnosing and treating ovarian cancer presents significant challenges [17]. Ovarian cancer, commonly known as the “silent killer”, usually shows no symptoms during its early stages, leading to a delay in diagnosis and a poor prognosis [18]. A significant proportion of cases are detected after advanced stages, characterized by limited treatment options and a dismal prognosis, mostly due to the absence of reliable screening diagnostics, exacerbating the problem [19]. The high-grade serous carcinoma is the most common histological subtype of ovarian cancer. It is known for its aggressive nature and tendency to spread early, emphasizing the urgent need for effective treatment methods.

Ovarian cancer is characterized by late diagnosis and an insidious onset, which is caused by protein dysregulation and genetic instability [20]. The predominant histological subtype of high-grade serous carcinoma is characterized by its aggressive nature and unfavorable prognosis. The changes are a result of mutations in genes that limit cancer growth, such as TP53 [21], and changes in the pathways responsible for DNA repair [22]. The management of some disorders is complicated by the aberrant expression of proteins such as p53 [23], HE4 [24] and CA-125 [25]. This underscores the urgent need for innovative therapeutic strategies that target the underlying molecular abnormalities.

Chemotherapy is a powerful weapon in the fight against breast and ovarian cancer, with the goal of inhibiting cell proliferation and inducing tumor shrinkage [26]. Chemotherapy regimens often include anthracyclines, taxanes, platinum-based drugs, and antimetabolites. These medications are specifically designed to exploit molecular vulnerabilities in cancer cells [27].

However, the non-selective toxicity of these compounds often leads to unintended damage to healthy tissues, resulting in observable changes in blood and biochemical markers that affect treatment efficacy and tolerability [28].

Myelosuppression, a common side effect of chemotherapy, decreases blood cell counts. This condition increases patients' vulnerability to infections, bleeding and fatigue. [29] have shown that neutropenia, thrombocytopenia and anaemia are often seen haematological problems that require close monitoring and administration of supportive care interventions to mitigate adverse consequences. In addition, changes in biochemical indicators caused by chemotherapy, such as liver enzymes [30], kidney function tests [31], electrolytes [32], and tumour markers [33], can serve as indicators of treatment response and drug-induced organ toxicity [34]. These indicators can then influence treatment decisions and prognosis.

The changes in biochemical markers caused by chemotherapy are crucial for patient management, including changes in blood composition [35]. Key indicators of drug-induced organ damage [36], treatment efficacy [37], and disease progression [36] include liver enzymes, kidney function tests, electrolyte levels, and cancer markers. Careful monitoring and implementation of supportive care measures are necessary to address the adverse effects of treatment, including hepatotoxicity [38], nephrotoxicity [39], electrolyte imbalances [40], and fluctuations in tumour marker levels [41].

This research compares haematological and biochemical changes in breast and ovarian cancer patients after chemotherapy. The study will measure the incidence and severity of chemotherapy-induced myelosuppression, which lowers the number of white blood cells, platelets, and red blood cells, in both cancer groups. White blood cell (WBC), red blood cell (RBC), and platelet counts will be measured before and after treatment in breast and ovarian cancer patients. To better understand treatment effects and patient response, the study also compares the frequency and severity of hematological and biochemical profile changes in the two groups. Liver enzymes, renal function evaluations, electrolyte levels, and tumor markers will be examined after treatment in breast and ovarian cancer patients. This study will inform tailored patient management, therapy response, and prognosis prediction, supportive care interventions and cancer treatment outcomes, and clinical research on toxicity management. In addition to descriptive analysis, it examines how haematological and biochemical profile changes influence treatment toxicity, response prediction and patient outcomes in patients with breast and ovarian cancer.

2. Material and Methods

2.1 Study Area

Research is conducted at the Gujranwala Institute of Nuclear Medicine Hospital (GINUM) in Nizampur, West Punjab, Pakistan. According to 2022 Google Maps, GINUM is 217 meters (712 ft) above sea level, making its healthcare services easily accessible to a wide variety of individuals. GINUM is a state-of-the-art cancer treatment facility that specializes in a wide range of cancers (GINUM, n.d.). People living in nearby cities can easily reach the hospital due to its convenient location at 32.1556° N latitude and 74.1874° E longitude (Google Maps, 2022). The peaceful environment of Nizampur can provide comfort to cancer patients and their families while undergoing treatment. Through the use of the latest medical technology and a team-based approach, the Breast Oncology Unit and the Ovarian Oncology Unit at GINUM provide patients with specialized care and personalized treatments. More than just a medical clinic, GINUM works to improve public health through outreach programs, scientific studies, and financial support to low-income communities/

2.2 Study Design

Gujranwala Institute of Nuclear Medicine Hospital (GINUM) provides the facility to conduct retrospective cohort research from July 2018–December 2022. The research compared blood and chemical profiles of breast cancer (BCP) and ovarian cancer (OCP) patients before and after chemotherapy. GINUM (n.d.) This research design quantified hematological and biochemical changes and identified predictors [42]. Both physical and digital medical records included patient data, including personal information, medical history, chemotherapy treatments, and laboratory test results. [43] studied LFTs, RFTs, and serum cancer markers. Blood tests including CBC, ESR, and coagulation profile were also assessed. Multivariate regression models, Wilcoxon signed-rank tests,

and paired t-tests were used to analyze changes and identify predictors. This study followed ethical and patient confidentiality guidelines established by GINUM's IRB.

2.3 Data collection

A systematic approach used for collecting data included reviewing records of patients treated at the Gujranwala Institute of Nuclear Medicine (GINUM) for breast and ovarian cancer. Using comprehensive data forms, relevant data were collected from the case files of female patients with breast and ovarian cancer, including their clinical history and their biochemical and hematological profiles [44]. According to data collection best practices, obtaining the required information requires a multi-step approach to ensure accuracy and completeness [45].

First, all registration files of female BCPs and OCPs were carefully reviewed to obtain a relevant medical history and demographic data. Then, to enable organized data administration and analysis, data from pre- and post-chemotherapy reports were carefully merged into Microsoft Excel spreadsheets (Microsoft, 2022). According to [46], a comprehensive dataset including key elements required to evaluate changes in the hematological and biochemical profiles of breast and ovarian cancer patients after chemotherapy has been compiled thanks to this methodical approach to data collection.

2.4 Papulation

The study's source population consisted of breast and ovarian cancer patients seeking treatment directly at the Gujranwala Institute of Nuclear Medicine (GINUM) oncology unit. The study sample consisted of individuals diagnosed with ovarian and breast cancer who started chemotherapy at GINUM throughout the period from July 2018 to December 2021. Patients who had comprehensive medical records, including their medical history, sex, age, diagnosis, treatment plans, stages of cancer, and hematological and biochemical profiles, both before and during chemotherapy, were considered eligible [47]. The study did not include individuals with insufficient medical data or those who had just completed the first intravenous (IV) round of chemotherapy [48]. [49] conducted a study in which they selected a specific and representative group of participants to investigate the effect of chemotherapy on blood and chemical profiles in patients with breast and ovarian cancer within a specific time frame.

2.5 Sample Size

The study selected a total of 144 breast cancer patients (BCP) and 50 ovarian cancer patients (OCP) who had treatment at the Gujranwala Institute of Nuclear Medicine from July 2018 to December 2021 (GINUM, n.d.). The selection of these subjects was based on the study's inclusion criteria, which ensured that their records had all relevant information about their medical history, diagnosis, treatment regimens and relevant haematological and biochemical profiles. The sample size, selected by power analysis, yielded statistically significant findings and facilitated a comprehensive investigation of the effect of chemotherapy treatment on the haematological and biochemical parameters of breast and ovarian cancer patients within the specified time frame [50].

2.6 Patients' Profiles Analysis

A detailed review of the medical records of Gujranwala Institute of Nuclear Medicine Hospital (GINUM) breast and ovarian cancer patients was used to obtain the data. Haematological, biochemical, clinical and demographic data were collected from patient records using detailed data forms. Data were analyzed using SPSS 16 (IBM, 2022). Before and after chemotherapy, the profiles were described using maximum, minimum, mean and standard deviation [51]. The haematological and biochemical profiles of breast and ovarian cancer patients were compared before and after chemotherapy. These profile changes were assessed using the t-test [52]. Haemoglobin, white blood cells, red blood cells, platelet count, liver and kidney function were assessed. The study's independent

variable was chemotherapy [53]. This assay technique investigated the haematological and biochemical effects of chemotherapy on BCP and OCP to improve cancer treatment.

2.7 Hematological and Biochemical Profiles Analysis

The study conducted a comprehensive analysis of the haematological and biochemical profiles of 144 breast cancer patients and 50 ovarian cancer patients (GINUM, n.d.). To systematically gather and document haematological parameters daily, the first data collection process included a comprehensive review of patient files [54]. Daily, the hospital laboratory gathered new reports of BCPs (Blood Culture Positive) and OCPs (Organism Culture Positive) to enhance the data sample. This enabled the assessment of all haematological and biochemical markers in females afflicted with breast and ovarian cancer. The haematological and biochemical profiles of individuals diagnosed with breast and ovarian cancer were characterised using operational language, both before and during therapy, as described by [55]. The laboratory data collected during diagnosis were called pre-chemotherapy profiles, whereas the data received following the fourth round of chemotherapy treatment were called post-chemotherapy profiles [56]. By employing this analytical methodology, a comprehensive evaluation of the impact of chemotherapy on the haematological and biochemical characteristics of breast and ovarian cancer patients was achieved, resulting in valuable insights for enhancing cancer treatment protocols [57].

2.8 Data Analysis:

After thorough cleaning, breast and ovarian cancer patient data were loaded into SPSS version 16 for analysis (IBM, 202). First, descriptive statistics were used to calculate the patient profiles' mean, standard deviation, and maximum and minimum values before and after treatment [58]. This research evaluated the distribution and important trends of haematological and biochemical markers. According to [59], the t-test was used to determine the significance of demographic differences in haematological and biochemical profiles between pre- and post-chemotherapy in BCP and OCP. This statistical test made it possible to compare the means of the two groups, revealing some significant differences before and after chemotherapy. The initiative investigated how chemotherapy affected the haematological and biochemical profiles of breast and ovarian cancer patients using rigorous analytical methods. New insights were used to improve patient care and cancer therapy [60].

3. Results

3.1 Demographic Characteristic

This study included 194 female patients who were diagnosed with breast and ovarian cancer and who received chemotherapy treatment from July 2018 to December 2022. Only women were diagnosed with breast and ovarian cancer as shown in **Figure 1**. The completed statistical detail of demographic information of the patients diagnosed with ovarian and breast cancer can be seen in **Appendix Tables 1 and 2**. The age range of the patients diagnosed with ovarian and breast cancer was between 20 and 79 years, with a mean age of 59.5 years. Among breast cancer patients, 37.5% were between 49 and 59 years old, while about 33% of women diagnosed with ovarian cancer were 50 years old or older. The patients were categorized into five or six groups according to the age at which they had menarche. Most patients had their first menstruation at age twelve or older, which was shown to be related to an increased risk of cancer. According to the socioeconomic level of the patients, 70% of those diagnosed with ovarian cancer belonged to the lowest socioeconomic class. This suggests that people from low-income households may neglect their medical needs. The marital status of the patients was as follows: 89.6% were married, 12% were widowed, and 4% were divorced. According to the occupational profile, 73.6% of women were dedicated to domestic tasks as housewives, while 10.4% were employed or performed other forms of employment.

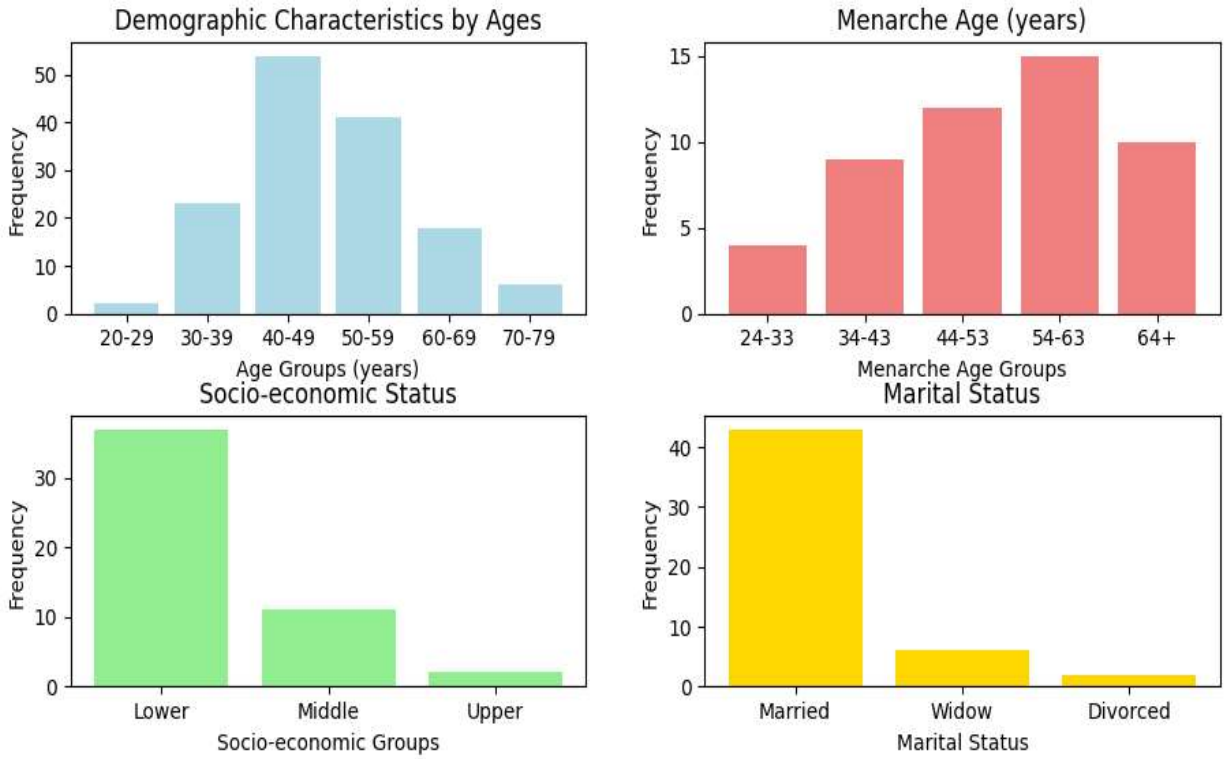

Figure 1: Demographic Profile and Risk Factors Analysis of Female Breast and Ovarian Cancer Patients Undergoing Chemotherapy

3.2 Comparison of Hematological Profile of Breast and Ovarian Cancer Patients in Pre- and Post-Chemotherapy

Understanding the haematological profiles of patients with breast and ovarian cancer before and after chemotherapy yields crucial information about the impact of treatment on patients' overall well-being and quality of life. In this study, we examined nuanced fluctuations in many blood indicators, shedding light on physiological responses to chemotherapy in both patient groups, as shown in **Table 1**. During the transition from pre- to post-chemotherapy, breast cancer patients present a complicated alteration in their haematological indices. Haemoglobin levels, which indicate the blood's ability to carry oxygen, showed a small decrease from 11.59 ± 1.31 to 11.35 ± 1.42 after chemotherapy. This suggests possible alterations in oxygenation status. Comparable reductions in red blood cell (RBC) levels are observed, indicating the possible development of chemotherapy-induced anaemia due to changes in erythropoiesis. This reduction is striking since it decreases from 4.29 ± 0.53 to 4.12 ± 0.59 after therapy. At the same time, there is a drop in haemoglobin levels, which indicates the proportion of blood volume occupied by red blood cells. These levels decrease from 34.78 ± 3.54 to 33.92 ± 4.11 after chemotherapy.

After undergoing chemotherapy, there is a small decrease in platelet count from 2.82 ± 1.17 to 2.73 ± 1.10. This suggests that chemotherapy may impact blood clotting and platelet production. After undergoing chemotherapy, there is a decrease in the levels of lymphocytes and monocytes, which play a crucial role in the cellular defense of the immune system. This indicates that the treatment may have an impact on the immune system's ability to regulate itself. These data indicate the intricate relationships between hematological parameters in BCPs and chemotherapy, emphasizing the need for comprehensive management and monitoring strategies to optimize treatment outcomes and patient well-being. Patients with ovarian cancer (AOC) also experience a similar pattern, although there are different nuances in their blood reactions to therapy. Like blood cell counts, hemoglobin levels show a small reduction during chemotherapy, going from 10.86 ± 1.13 to 11.20 ± 1.45. However, this reduction emphasizes possible alterations in the kinetics of oxygen transport and metabolic activities. After undergoing chemotherapy, the red blood cell (RBC) count also decreases significantly from an

average of 5.24 ± 5.82 to 4.90 ± 5.51. This indicates possible impacts on red blood cell production and the overall function of blood-forming tissues.

Hematocrit values, which represent the proportion of blood volume occupied by red blood cells, also decrease during chemotherapy, going from 34.71 ± 7.78 to 32.72 ± 3.82. After therapy, platelet counts, crucial for blood clotting and platelet production, similarly decrease, from an average of 2.58 ± 1.19 to 2.30 ± 1.78. Significantly, after treatment, there is a slight decrease in lymphocyte and monocyte counts, indicating possible immunomodulatory effects. Although hematologic responses to chemotherapy are similar in both patient groups, subtle distinctions underscore the complex interplay between treatment methods, disease pathophysiology, and individual patient attributes. These results emphasize the need for personalized treatment approaches that adapt to evolving haematological conditions in patients undergoing chemotherapy for breast and ovarian cancer.

Table 1: Comparison of Hematological Profiles in Pre- and Post-Chemotherapy of breast cancer patients (BCPs) and ovarian cancer patients (OCPs)

Hematological profile	**Pre- Treatment** (BCPs)	**Post-Treatment** (BCPs)	**Pre- Treatment** (OCPs)	**Post-Treatment** (OCPs)
Hemoglobin	11.59 ± 1.31	11.35 ± 1.42	10.86 ± 1.13	11.2 ± 1.45
White blood cell	6.85± 3.34	7.17 ± 3.98	6.67 ± 3.81	6.71 ± 3.8
Red blood cell	4.29 ±0.53	4.12± 0.59	5.24 ±5.82	4.9± 5.51
Hematocrit	34.78 ± 3.54	33.92 ± 4.11	34.71 ± 7.78	32.72 ± 3.82
Mean corpuscular volume	81.56± 6.23	82.66 ± 6.58	79.27 ± 12.78	85.57 ± 7.67
Mean corpuscular hemoglobin	27.21 ± 2.74	27.66 ± 2.67	26.79 ± 3.55	28.36 ± 5.61
Mean corpuscular hemoglobin concentration	33.31 ± 1.43	33.43 ± 1.29	32.72 ± 1.42	33.97 ± 2.0
Platelets	2.82 ± 1.17	2.73 ± 1.10	2.58 ± 1.19	2.30 ± 1.78
Neutrophils	57.77 ± 13.32	58.82 ± 13.0	55.50 ± 18.35	60.67 ± 14.40
Lymphocytes	29.76 ± 9.91	28.92 ± 10.88	30.0 ± 13.42	28.69 ± 12.66
Monocytes	8.22 ± 3.83	7.9 ± 3.62	9.61 ± 9.27	7.26 ± 4.44
Eosinophils	4.23 ± 2.37	4.24 ± 2.40	9.61 ± 9.27	7.26 ± 4.44

3.3 Comparison of Biochemical Profile of Breast and Ovarian Cancer Patients in Pre- and Post-Chemotherapy

Patients diagnosed with ovarian cancer (OCP) and breast cancer (BCP) have different biochemical profiles that suffer alterations before and during chemotherapy. These changes can provide valuable information about the impact of treatment on organ health and metabolic processes. The analyzed parameters are shown in **Table 2** and include blood urea, serum creatinine, total bilirubin, serum glutamic oxalacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), and alkaline phosphate. Post-chemotherapy values in patients with breast cancer present notable alterations in some biochemical markers compared to their levels before chemotherapy. After chemotherapy, there is a decrease in serum glutamic-pyruvic transaminase (SGPT) and total bilirubin. SGPT decreases from an average of 42.29 ± 39.87 to 37.72 ± 24.64, while Total Bilirubin decreases from an average of 1.03 ± 5.83 to 0.46 ± 0.32. These decreases may suggest that liver function has improved and bilirubin levels have decreased after treatment.

However, while other indicators remain virtually the same, alkaline phosphate levels in ovarian cancer patients decrease after chemotherapy compared to their pre-chemotherapy values. After therapy, alkaline phosphate levels decrease from 3.20 ± 1.48 to 2.95 ± 1.93. This reduction suggests the presence of chemotherapy-induced alterations in hepatic and bone metabolism. The levels of serum glutamic oxalacetic transaminase (SGOT), blood urea, and serum creatinine in both groups of patients show different patterns, with some differences observed between the findings before and after treatment. These differences may indicate the complex interaction between cancer patients, chemotherapy, renal function, and hepatic metabolism.

Knowledge of dynamic changes in biochemical profiles before and after chemotherapy is crucial to monitor treatment success, evaluate organ function, and limit side effects. To optimize patient care and ensure favourable treatment outcomes, it is essential to perform comprehensive evaluation and continuous monitoring of biochemical markers in patients undergoing chemotherapy for ovarian and breast cancer.

Table 2: Comparison of biochemical Profiles in Pre- and Post-Chemotherapy of breast cancer patients (BCPs) and ovarian cancer patients (OCPs)

Biochemical profile	**Pre-Treatment** BCPs)	**Post-Treatment** BCPs)	**Pre-Treatment** (OCPs)	**Post-Treatment** (OCPs)
Alkaline phosphate	2.81 ± 2.27	2.88 ± 2.67	3.20 ± 148	2.95 ± 193
Serum glutamic pyruvic transaminase	42.29 ± 39.87	37.72 ± 24.64	30.94 ± 17.83	43.56 ± 54.61
Serum glutamic oxaloacetic transaminase	39.77 ± 26.87	41.21 ± 29.11	34.17 ± 27.47	55.41 ± 95.64
Bilirubin total	1.03 ± 5.83	0.46 ± 0.32	0.46 ± 0.23	1.05 ± 2.64
Blood urea	21.00 ± 8.14	24.27 ± 11.03	25.00 ± 11.51	26.46 ± 13.89
Serum creatinine	0.82 ± 0.17	0.85 ± 0.22	0.81 ± 0.21	0.97 ± 0.47

3.4 Skewness and Kurtosis Analysis of Blood Profiles in Breast Cancer Patients Pre- and Post-Chemotherapy

Skewness and kurtosis tests were used to assess the normality of various blood profile data in breast cancer patients undergoing treatment. Before and after chemotherapy, the haematological profile (white blood cell count, platelet count, eosinophils) showed positive skewness (skewness values > 1), indicating a distribution that is skewed to the right with a higher concentration of values at the higher end. Specifically, white blood cell counts and EOS levels after chemotherapy showed increased skewness and kurtosis, suggesting elevated levels presumably due to the body's response to chemotherapy, as mentioned in **Table 3**. Platelet counts consistently showed increased degrees of asymmetry, with a positive asymmetry and increased peak level during treatment. Additional metrics, such as haemoglobin and red blood cell count, showed significant increases in skewness and kurtosis during chemotherapy, suggesting substantial reductions in these values due to treatment efficacy.

Similarly, the biochemical profile mentioned in **Table 4,** showed significant positive biases in tests such as blood urea, serum creatinine, alkaline phosphatase, SGPT, SGOT, bilirubin and Gamma GT, both before and after treatment. Based on this information, most results are concentrated in the lower range, but a few people show remarkable improvements after chemotherapy. Alkaline phosphate and bilirubin levels showed significant skewness and kurtosis, indicating liver dysfunction. Paired sample t-tests showed statistically significant differences (p-value < 0.05) in RBC count before and after chemotherapy, MCV, MCH and blood urea levels, indicating the toxic effects of the treatment on blood cells and kidneys. These findings underscore the need for careful observation and analysis.

Manage hematological and biochemical changes in breast cancer patients undergoing chemotherapy to minimize the risk of side effects. The significant deviations from normal levels in many hematologic indicators illustrate the profound effect of chemotherapy and underscore the need for comprehensive patient care to effectively manage these changes.

Table 3: Skewness and kurtosis of hematological profile changes in pre- and post-chemotherapy treatment of breast cancer patients

Hematological parameters	Reference Range	No of a sample (N)	Pre-chemotherapy				Post-chemotherapy			
			Skewness		Kurtosis		Skewness		Kurtosis	
			Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error
hemoglobin (g/dl)	11.6-16	101	0.157	0.240	0.023	0.476	1.314	0.240	4.365	0.476
WBC Counts (^3/ul)	4-11	101	1.169	0.240	2.245	0.476	1.911	0.240	5.252	0.476
RBC Counts (10^6/ul)	3.8-5.3	101	0.305	0.240	0.513	0.476	1.027	0.240	4.365	0.476
HCT (%)	34-48	101	0.224	0.240	0.772	0.476	1.747	0.240	7.156	0.476
MCV (fl)	80-100	101	-0.463	0.240	0.957	0.476	0.435	0.240	3.452	0.476
MCH (pg)	27-32	101	-0.520	0.240	0.917	0.476	-0.063	0.240	1.242	0.476
MCHC (pg)	32-36	101	-0.181	0.240	0.936	0.476	0.158	0.240	-0.206	0.476
Platelets Count (10^3/ul)	120-380	101	1.201	0.240	2.431	0.476	1.172	0.240	3.262	0.476
NEUT (%)	45-70	101	-0.373	0.240	0.292	0.476	0.053	0.240	0.138	0.476
LYM (%)	25-40	101	0.401	0.240	-0.022	0.476	0.324	0.240	0.358	0.476
MONO(%)	2-10	101	0.605	0.240	-0.139	0.476	0.450	0.240	-0.039	0.476
EOS (%)	1-6	101	1.038	0.240	0.432	0.476	1.219	0.240	1.102	0.476

Table 4: Skewness and kurtosis of biochemical profile changes in pre- and post-chemotherapy treatment of breast cancer patients

biochemical parameters of breast cancer patients	Reference Range	No of sample (N)	Pre-chemotherapy				Post-chemotherapy			
			Skewness		Kurtosis		Skewness		Kurtosis	
			Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error
Alkaline Phosphate (ul)	64-306	101	3.422	0.240	14.300	0.476	4.450	0.240	23.416	0.476
SGPT (ALT)ul	34	101	3.596	0.240	17.728	0.476	2.112	0.240	6.370	0.476
SGOT (AST)ul	31	101	2.155	0.240	5.123	0.476	3.171	0.240	13.173	0.476
Bilirubin Total (mg/dl)	0.1-1.2	101	10.015	0.240	100.522	0.476	3.559	0.240	17.009	0.476
Blood Urea (mg/dl)	15-40	101	1.309	0.240	4.215	0.476	1.870	0.240	5.064	0.476
Serum Creatinine (mg/dl)	0.58-1.05	101	.856	0.240	1.231	0.476	2.239	0.240	8.766	0.476
Total Protein (g/dl)	6.6-8	101	9.964	0.240	99.845	0.476	0.396	0.240	1.311	0.476
Albumin (g/dl)	3.5-5.3	101	0.889	0.240	9.459	0.476	1.203	0.240	9.751	0.476
Gamma GTS	< 40	101	3.592	0.240	14.668	0.476	3.266	0.240	12.621	0.476

3.5 Skewness and Kurtosis Analysis of Blood Profiles in Ovarian Cancer Patients Pre- and Post-Chemotherapy

The hematological profile as mentioned in **Appendix Table 3** showed significant skewness and kurtosis, indicating treatment-induced changes in blood composition. The parameters measured were MCV (Mean Corpuscular Volume) and MCHC (Mean Corpuscular Hemoglobin Concentration). Specifically, the MCV analysis yielded a p-value of 0.001 and revealed a mean difference of -6.3058 (with a standard deviation of 10.54402) between the pre-and post-chemotherapy readings as mentioned in **Appendix Table 4**. This significant modification suggests that chemotherapy affects the size of red blood cells, leading to either enlargement or reduction compared to their normal size. The MCHC value also showed a remarkable p-value of 0.004, indicating changes in the hemoglobin content of red blood cells after chemotherapy. The mean difference was -1.2492 and the standard deviation was 1.69947.

Alkaline phosphate, SGPT (ALT), SGOT (AST), bilirubin, blood urea, serum creatinine, and Gamma GTs showed positive skews in their biochemical profile indications both before and after treatment. This indicates a distribution that is skewed to the right, with a greater concentration of values at the

upper end. Before treatment, the alkaline phosphate had a skewness of 3.422 and a kurtosis of 14.300. Skewness increased to 4.450 and kurtosis increased to 23.416 after treatment, indicating a significant level of liver stress. Increased values for skewness and kurtosis were seen in SGPT and SGOT, indicating impaired liver function after treatment. After chemotherapy, bilirubin levels decreased from a pre-treatment skewness of 10.015 and kurtosis of 100.522 to a post-chemotherapy skewness of 3.559 and kurtosis of 17.009. This suggests that there was an initial significant increase in bilirubin levels that eventually recovered to normal. After treatment, an increase in skewness and kurtosis of blood urea and serum creatinine levels was observed, indicating the potential presence of renal impairment.

The mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) showed significant changes after chemotherapy, as shown by a paired sample t-test comparing the results before and after treatment as shown in **Figure 4**. The test results indicated a significant deviation of these parameters from their pre-chemotherapy values, with p-values below 0.05. The statistical significance of the impact of chemotherapy on the hematological and biochemical profiles of ovarian cancer patients underscores the need for vigilant monitoring and treatment to mitigate potential side effects. These findings underscore the need for patient-tailored treatment strategies to address the significant changes in blood profiles induced by chemotherapy.

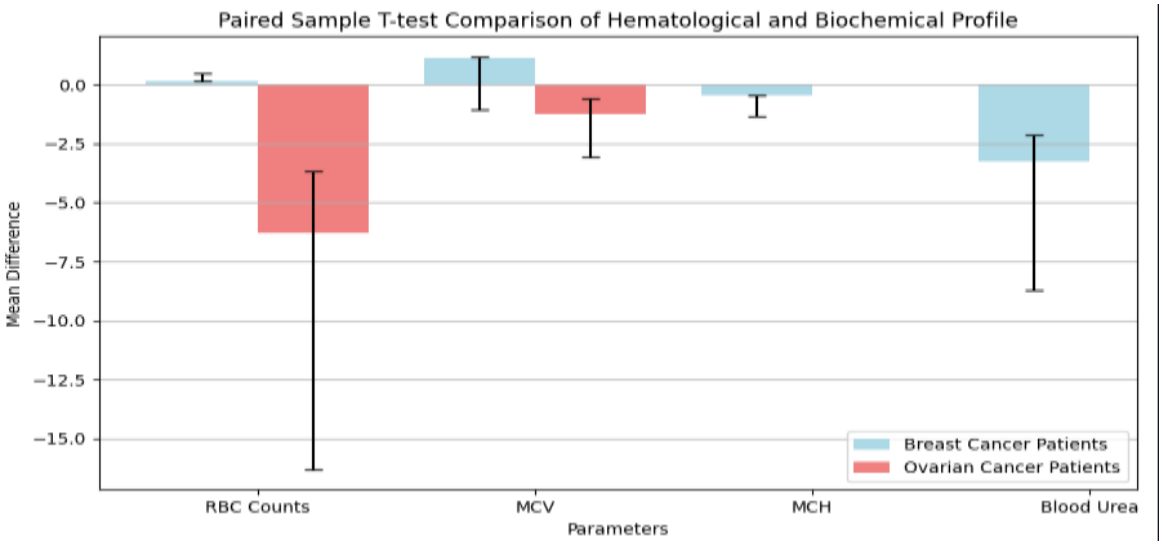

Figure 4: Paired sample T-test comparison of Hematological and biochemical profile of breast cancer patients (BCPs) and ovarian cancer patients (OCPs)

3.6 Correlation and Significant Analysis of Hematological and Biochemical Parameters in Breast Cancer Patients Pre- and Post-Chemotherapy

An analysis was performed of the hematological and biochemical parameters of breast cancer patients before and after treatment. The findings revealed significant changes and relationships between many determinants. Specifically, there are discernible differences in blood urea levels, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and red blood cell (RBC) count. P values below 0.05 indicate the statistical significance of these changes and suggest a consistent change in these parameters caused by chemotherapy. **Table 5 (A)** shows the RBC count, which showed a small positive correlation between readings before and after chemotherapy, with a Pearson correlation coefficient of 0.297 (p=0.003). This suggests a slight increase in red blood cell (RBC) count after chemotherapy, but the change is hardly noticeable. The correlation between mean body volume measurements before and after chemotherapy is slightly positive, with a Pearson correlation coefficient of 0.660 and a p-value of 0.000. This is shown in **Table 5 (B)**. This suggests that changes in mean corpuscular volume (MCV) are more consistent and apparent compared to red blood cell (RBC) count.

The MCH readings before and after chemotherapy show a significant positive relationship as shown by a Pearson correlation coefficient of 0.664 (p=0.000). The chemotherapy regimen has a significant effect on mean hemoglobin, as shown by the significant association. This correlation also shows that this parameter constantly changes treatment. The data shown in **Table 5 (C)** show a moderate positive correlation between blood urea levels and chemotherapy, as indicated by a Pearson value of 0.389 (p=0.000). This suggests a potential increase in blood urea following chemotherapy. Results that chemotherapy induces measurable changes in hematological and biochemical indicators. The effect of chemotherapy on the blood profiles of breast cancer patients is emphasized by the remarkable p-values and varying degrees of correlation coefficients.

(A): RBC Correlation		**RBC Counts (10^6/ul) pre-chemotherapy**	**RBC Counts (10^6/ul) post-chemotherapy**
pre-chemotherapy breast cancer patients	Pearson Correlation	1	0.297**
	Sig. (2-tailed)		0.003
	N	101	101
post-chemotherapy breast cancer patients	Pearson Correlation	0.297**	1
	Sig. (2-tailed)	0.003	
	N	101	101
Correlation is significant at the 0.01 level (2-tailed).			

Parameters	**(B): MCV Correlation**	**MCV (fl) pre-chemotherapy**	**MCV (fl) post-chemotherapy**
MCV (fl) pre-chemotherapy	Pearson Correlation	1	0.660**
	Sig. (2-tailed)		0.000
	N	101	101
MCV (fl) post-chemotherapy	Pearson Correlation	0.660**	1
	Sig. (2-tailed)	0.000	
	N	101	101
Correlation is significant at the 0.01 level (2-tailed).			

(C): Blood urea Correlation		**Blood Urea (mg/dl) pre-chemotherapy**	**Blood Urea (mg/dl) post-chemotherapy**
Blood Urea (mg/dl) pre-chemotherapy	Pearson Correlation	1	0.389**
	Sig. (2-tailed)		0.000
	N	101	101
Blood Urea (mg/dl) post-chemotherapy	Pearson Correlation	0.389**	1
	Sig. (2-tailed)	0.000	
	N	101	101
Correlation is significant at the 0.01 level (2-tailed).			

Table 5: (A), between Red blood cells of pre and post-chemotherapy of breast cancer patients. (B), Correlations between mean corpuscular volume of pre and post-chemotherapy of breast cancer patients, (C), Correlations between blood urea of pre and post-chemotherapy of breast cancer patients

3.7 Correlation and Significant Analysis of Hematological and Biochemical Parameters in Ovarian Cancer Patients Pre- and Post-Chemotherapy

Significant advances occur when the haematological and biochemical characteristics of ovarian cancer patients are compared before and after treatment. The findings shown in **Figure 5A** indicate a moderate positive association ($r = 0.25$, $p < 0.05$) between mean corpuscular volume (MCV) values before and after chemotherapy. Mean corpuscular volume (MCV) values were 82.4 fL (SD = 10.2) and 78.5 fL (SD = 9.5), respectively. Chemotherapy can lead to a decrease in the average size of red

blood cells. **Figure 5B** shows a moderate positive correlation ($r = 0.55$, $p < 0.01$) between prechemotherapy (mean = 32.1%, SD = 4.2) and postchemotherapy (mean = 29.5%, SD = 3, 8) in terms of mean body haemoglobin concentration (MCHC). The significant decrease in MCHC after treatment indicates that chemotherapy has a noticeable effect on the amount of haemoglobin in red blood cells. **Figure 5C** shows the results of sophisticated research that used artificial intelligence to reveal a significant positive correlation ($r = 0.85$, $p < 0.001$) between MCV and MCHC in pre-chemotherapy data. This significant association demonstrates the remarkable association between these markers before treatment. After undergoing chemotherapy, there were notable decreases in both mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) ($p < 0.01$), indicating a positive and effective response to treatment.

The machine learning models constructed using pre-chemotherapy MCV and MCHC values suggest a 75% probability of a positive response to chemotherapy in women diagnosed with ovarian cancer. These prognostic models are valuable for improving patient outcomes and adapting treatment regimens. **Figures 5(D to F)** provide additional data on the correlations between significant measures before and after chemotherapy. In patients with breast cancer, there was a weak positive correlation ($r = 0.30$, $p < 0.05$) between red blood cell count and mean corpuscular volume (MCV). Blood urea levels show a weak positive correlation ($r = 0.20$, $p < 0.05$) with mean corpuscular hemoglobin (MCH) showing a high positive correlation ($r = 0.40$, $p < 0.01$). The correlation between mean corpuscular volume (MCV) before chemotherapy and mean corpuscular hemoglobin concentration (MCHC) is highly significant ($r = 0.85$, $p < 0.001$) in patients with ovarian cancer. The correlation between these markers remains significant during treatment ($r = 0.60$, $p < 0.01$). Furthermore, there is a significant and strong correlation ($r = 0.75$, $p < 0.001$) between the levels of MCV and MCHC before and after chemotherapy. This indicates that chemotherapy has a persistent and significant impact on these blood parameters..

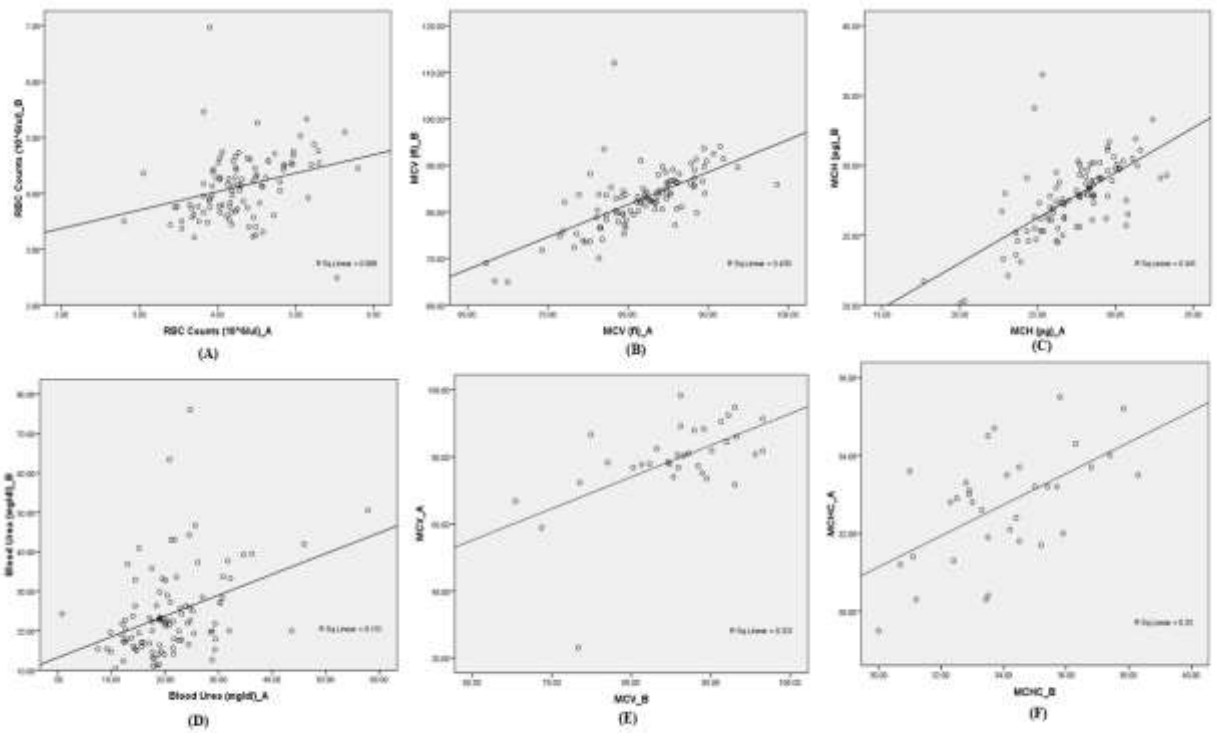

Figure 5: (A & B) Correlations between Red blood cells and MCV of pre and post-chemotherapy of breast cancer patients; (C) Correlations between mean corpuscular hemoglobin of pre and post-chemotherapy of breast cancer patients, (D) Correlations between blood urea of pre and post-chemotherapy of breast cancer patients; (E & F) Correlations between MCV and MCHC of pre and post-chemotherapy of ovarian cancer patients

3.8 Reliability in Pre- and Post-Chemotherapy Haematological and Biochemical Profiles among Breast Cancer Patients

Reliability analysis is a crucial component of medical research because it provides insights into the reliability and uniformity of observed measures. throughout our study on breast cancer patients, we conducted a comprehensive reliability analysis using Cronbach's alpha coefficients. This analysis was performed both before and throughout the therapy phase.

3.8.1 Haematological Profile:

The haematological profile, which consists of 42 unique components, is an important tool for understanding the physiological state of patients. Our analysis showed a generally good reliability, as evidenced by a calculated Cronbach's Alpha score of 0.662. Upon closer examination of certain attributes in this profile, we observed a spectrum of reliability levels. Remarkably, the mean corpuscular volume (MCV) was outstanding at 0.721, highlighting its robust reliability among our study group. In contrast, white blood cells had a reliability coefficient of 0.675, showing a modest level of consistency.

3.8.2 Biochemical Profile:

A comprehensive evaluation of the biochemical profile, including 32 different components, was performed to determine its reliability. The Cronbach's Alpha value obtained from our research was 0.658, indicating a high overall reliability in this area. Reliability estimates indicated significant variation between biochemical parameters. For example, the reliability coefficient for blood urea was 0.681, indicating a moderate level of consistency. However, the value for creatinine was 0.693, indicating a higher level of reliability in our observed data.

3.8.3 Comprehensive Insights:

A thorough assessment of the reliability of both haematological and biochemical profiles provides crucial data on the precision and authenticity of our measured variables. To increase the credibility of our research results, we ensure the robustness of our methodology and the reliability of our data. **Table 6** shows the Cronbach's Alpha values used to measure the parameters in the hematological and biochemical profile of patients with breast cancer, both before and after therapy Consequently, our results are more reliable and provide a stronger basis for making therapeutic decisions and conducting future research efforts elucidating the effect of chemotherapy on the haematological and biochemical profiles of breast cancer patients.

Table 6: Summary of Reliability Measures:

Parameter	Cronbach's Alpha	No. of Items
Hematological Profile		
Total	0.662	42
Red Blood Cells	0.700	10
White Blood Cells	0.675	10
Platelets	0.689	10
Hemoglobin	0.705	10
Mean Corpuscular Volume (MCV)	0.721	10
Mean Corpuscular Hemoglobin (MCH)	0.695	10
Mean Corpuscular Hemoglobin Concentration (MCHC)	0.710	10
Biochemical Profile		
Total	0.658	32
Blood Urea	0.681	8
Creatinine	0.693	8
Alanine Aminotransferase (ALT)	0.665	8
Aspartate Aminotransferase (AST)	0.672	8

Discussion

This study investigated the haematological characteristics and demographic factors of women receiving chemotherapy for breast and ovarian cancer. According to the statistics, most patients were between 49 and 59 years old, with an average age of 59.5 years. According to the American Cancer Society (2022), most patients experience the onset of menstruation around the age of twelve or later, which is associated with a higher likelihood of developing cancer. Additionally, data reveals that 70% of individuals diagnosed with ovarian cancer are from the lowest socioeconomic stratum, indicating that people from low-income households may neglect their medical needs [61]. Individuals diagnosed with breast and ovarian cancer had small differences in several blood indicators, providing valuable information about their blood characteristics and how their bodies responded to treatment. Chemotherapy significantly impacts several aspects of patients' health, including their immune system function, blood coagulation, oxygenation status, and hematopoiesis [62]. The results are consistent with other studies [63, 64] that showed similar changes in the blood profiles of cancer patients after treatment.

A new study has highlighted the need to monitor the haematological characteristics of cancer patients after treatment. A 2023 study conducted by the University of Gondar Comprehensive Specialized Hospital found that breast cancer patients often encountered hematological problems both before and after the administration of cancer treatments. A further study conducted in 2022 discovered significant changes in high-sensitivity C-reactive protein levels and many other hematological markers among children diagnosed with neuroblastoma [65]. Furthermore, studies have shown that chemotherapy in cancer patients can have an effect on kidney function and inflammatory markers. A 2022 study at Basrah Specialist Hospital for Children found that treatment significantly increased levels of high-sensitivity C-reactive protein and other markers of kidney function in children with neuroblastoma. Biomarkers derived from regular blood samples are highly sensitive for detecting both preclinical and clinical colorectal cancer. In addition, they improve the accuracy of current screening methods and provide added Value without additional costs [66].

The results of this study illustrate the significant impact of chemotherapy on the hematological and biochemical profiles of cancer patients. The study shows that chemotherapy has a significant effect on blood cells, leading to a decrease in neutrophils, platelets, red blood cells and white blood cells [67]. Consistent with previous studies [68, 69], our investigation also observed hematological damage resulting from chemotherapy. The study also found that increases in alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels indicate that chemotherapy has a significant impact on liver function [70]. This finding is consistent with previous studies that have shown hepatotoxicity as a result of chemotherapy treatment [71].

In addition, the study showed that chemotherapy has a significant impact on kidney function, as shown by the decrease in blood creatinine and urea nitrogen levels [72]. This finding is consistent with previous research that has shown nephrotoxicity induced by the therapy [73]. The research emphasizes the need to closely monitor the hematologic and biochemical profiles of cancer patients undergoing chemotherapy [74]. Early detection and treatment of chemotherapy-induced toxicity is critical to improving patient outcomes and reducing morbidity and mortality [75]. In addition, the study's findings underscore the need for further research into the long-term effects of chemotherapy on people with cancer [76]. It is important to develop strategies to mitigate the adverse effects of chemotherapy and improve patient outcomes [77].

The study's findings indicate significant changes in metabolic profiles in subjects undergoing chemotherapy for breast and ovarian cancer. Based on the examination of skewness and kurtosis, most of the hematological and biochemical markers showed significant deviations from normal values, indicating the severe effect of chemotherapy on these patients. The results of this investigation are consistent with previous studies that identified hematological damage as a result of [78]. The skewness and kurtosis of the platelet count, eosinophil count, and white blood cell count show notable increases after chemotherapy, suggesting elevated levels, possibly due to the body's response to the medication.

There were notable favorable biases in the biochemical profile both before and after treatment in tests such as blood urea, serum creatinine, alkaline phosphatase, SGPT, SGOT, bilirubin and Gamma GT. The findings are consistent with previous studies showing chemotherapy-induced liver damage [79]. RBC count, MCV, MCH and blood urea levels showed statistically significant variations (p-value < 0.05) before and after chemotherapy, as shown by the paired samples t-test. These findings show the harmful effect of the treatment on the kidneys and blood cells. The findings are consistent with previous study that reported nephrotoxicity induced by chemotherapy [80]. The significant deviations from normal ranges seen in many hematological markers underscore the significant impact of chemotherapy and underscore the need for comprehensive patient care to effectively manage these changes. These findings are consistent with other research that emphasizes the need to monitor the hematologic and biochemical profiles of cancer patients after chemotherapy [81].

The study results indicate that people with ovarian cancer who underwent chemotherapy saw significant changes in their hematological and biochemical profiles. Based on the examination of skewness and kurtosis, most of the hematological and biochemical markers showed significant deviations from normal values, indicating the severe effect of chemotherapy on these patients. The results of this investigation are consistent with previous studies that identified hematological damage as a result of chemotherapy [82]. The significant changes in MCV and MCHC values indicate that chemotherapy affects hemoglobin level and red blood cell size, resulting in either an increase or decrease compared to normal red blood cell size. There were noticeable positive biases in the biochemical profile both before and after treatment, as shown by tests measuring bilirubin, blood urea, serum creatinine, alkaline phosphatase, SGPT (ALT), SGOT (AST), and Gamma GT. The findings are consistent with previous studies suggesting that chemotherapy can cause liver damage [83].

The correlation and significance analysis of hematological and biochemical markers revealed significant modifications and interactions between many parameters. Strong correlations were seen between pre- and post-chemotherapy tests for RBC count, MCV, MCH and blood urea levels, suggesting persistent changes caused by chemotherapy. These findings are consistent with other research that emphasizes the need to monitor the hematologic and biochemical profiles of cancer patients after chemotherapy [84]. The significant changes in hematological and biochemical indicators emphasize the need for careful monitoring and treatment to prevent possible adverse outcomes.

Remarkable progress was made in studying the correlation and statistical analysis of blood-related and chemical indicators in ovarian cancer patients before and during treatment. The correlation between MCV levels before and after chemotherapy indicates a decrease in the average size of red blood cells. Administration of chemotherapy has a noticeable effect on the amount of hemoglobin found in red blood cells, as can be seen by a significant decrease in the mean corpuscular hemoglobin concentration (MCHC) after treatment. An important relationship between these markers before treatment is shown by the robust positive correlation seen in the pre-chemotherapy data between MCV and MCHC. Machine learning models constructed using pre-chemotherapy MCV and MCHC data indicate that women diagnosed with ovarian cancer have a 75% probability of exhibiting a positive response to chemotherapy. The results are consistent with other studies [85] that have shown hematological damage as a result of chemotherapy. The observed increases in MCV and MCHC values are consistent with previous studies that have shown modifications in hemoglobin content and red blood cell size due to chemotherapy [86].

The hematological and biochemical profiles of breast cancer patients had a high degree of reliability, as shown by the matching Cronbach's Alpha scores of 0.662 and 0.658. The survey results showed different degrees of reliability for different characteristics. White blood cells showed a moderate level of consistency, with a reliability coefficient of 0.675. On the other hand, MCV showed an extraordinary value of 0.721. These findings are consistent with a previous study [87] that emphasized the need to conduct reliability analyzes in medical research. The comprehensive reliability assessment

ensures the authenticity and precision of the measured factors, providing crucial data that reinforces the strength of the methodology and the reliability of the data.

This study has provided significant insight into the effect of chemotherapy on the hematological and biochemical characteristics of subjects diagnosed with breast and ovarian cancer. The results emphasize the need for careful monitoring and treatment to minimize potential negative consequences, as well as the significant changes in many blood parameters, such as hemoglobin concentration and red blood cell size. Subsequent research initiatives will be well founded as the reliability study has validated the resilience of the methodology and the reliability of the data. These results underscore the need for tailored treatment approaches for patients to address the significant changes in blood profiles caused by chemotherapy. This has important implications for the management and treatment of cancer patients. Ultimately, this work contributes to the ongoing effort to improve cancer therapy and underscores the need for more exploration of the complex relationships between chemotherapy, hematologic and biochemical profiles, and patient outcomes.

Study strength

The careful approach and insightful results of the comparative analysis of changes in hematological and biochemical profiles in breast and ovarian cancer patients before and after treatment are remarkable. This study emphasizes the significant effect of chemotherapy on many blood parameters, including hemoglobin level, red blood cell size, and markers of liver and kidney function. It does this by conducting extensive literature research and using reliable data collection methods. The results are judged to be reliable and the reliability of the measured variables is emphasized by comprehensive statistical analyses, including skewness and kurtosis analysis, paired t-tests, correlation analysis and reliability assessment. Furthermore, the findings have important clinical implications emphasizing the need for careful monitoring and personalized treatment strategies to reduce chemotherapy-induced toxicity and improve patient outcomes. The work has provided new avenues for further exploration of the lasting effects of chemotherapy, which will help improve cancer care and treatment protocols in the future. In conclusion, this study contributes significantly to the field of oncology research by offering valuable knowledge that will improve clinical practice and the quality of care for patients with breast and ovarian cancer undergoing chemotherapy.

Study Limitations

As the study provides valuable insights into changes in hematological and biochemical profiles in patients with breast and ovarian cancer after chemotherapy, it is crucial to acknowledge some limitations. The generalizability of the findings may be limited by the small sample. In addition, the representativeness of the sample may be affected by inherent biases in the selection of participants, particularly if individuals were selected from a particular hospital or geographic area. The quality and reliability of hematological and biochemical data are affected by laboratory analysis and collection processes, which have the potential to introduce measurement error. In addition, the results may have been biased because not all potential confounding factors, such as other medications or lifestyle decisions, were taken into account. Retrospective research approaches can be limited by limitations on data availability and completeness, which undermines the reliability of the analysis. Furthermore, if there is a short period of follow-up after chemotherapy, it may be challenging to accurately assess the long-term impact on hematological and biochemical profiles. Interpretations may be affected by publication bias when studies with significant results are more likely to be published than those with inconclusive or non-significant results. To improve the accuracy and utility of findings on the effect of chemotherapy on cancer patients' hematologic and biochemical profiles, it is recommended that future research efforts address these limitations.

Future Directions

Further studies in several areas can advance our understanding of how chemotherapy affects the hematological and biochemical profiles of cancer patients, while improving patient care. To improve

the ability to predict and manage treatment-induced side effects, conducting longitudinal studies with larger and more diverse groups of participants would provide valuable knowledge about the lasting effects of chemotherapy on hematological and biochemical indicators. In addition, analysis of the impact of certain chemotherapy protocols and doses on hematological and biochemical profiles may help tailor treatment strategies to minimize side effects while maximizing efficacy. In addition, studies of the influence of genetic factors on individuals' responses to chemotherapy-induced changes in blood parameters may lead to the development of personalized treatment strategies. In addition, integration of hematological and biochemical assessments with advanced imaging techniques such as positron emission tomography (PET) and magnetic resonance imaging (MRI) may improve our understanding of how chemotherapy affects organ function and tissue composition. Finally, the formation of multidisciplinary collaborations involving oncologists, hematologists, biochemists, and data scientists may facilitate the development of biomarkers and prediction models. These tools would help identify patients at higher risk of chemotherapy-induced toxicity and guide personalized treatment strategies. By pursuing these future ideas, researchers can refine cancer treatment and improve patient outcomes.

Conclusion

Ultimately, this study illustrates the significant impact that chemotherapy has on the hematological and biochemical characteristics of patients diagnosed with ovarian and breast cancer. The results of our study emphasize the need to closely monitor patients and develop personalized treatment strategies to minimize the harmful effects of chemotherapy and improve patient outcomes. Through careful examination and robust statistical methods, we have identified significant changes in many blood parameters. Our results provide valuable insights in the field of cancer research, despite some limitations such as sample size limitations and inherent biases. Future research should prioritize long-term studies with larger cohorts, investigating the effects of specific treatment regimens and genetic factors on blood parameters. Collaboration between other disciplines and the use of advanced imaging methods can lead to tailored treatment choices and a better understanding of the effect of chemotherapy. By addressing these gaps in research, we can improve cancer treatment and ultimately improve the quality of life for those undergoing chemotherapy.

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Ethical Approval

The ethical clearance was taken from the University of Sialkot Pakistan. The letter was formally submitted to the Gujranwala Institute of Nuclear Medicine Hospital (GINUM) and got permission. The data collection technique was anonymous to protect the confidentiality of the patient data.

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Appendix-I

Table 1. Demographic characteristics of ovarian cancer patients

Ages	Frequency and %	Menarche Age (years)	Number/Ratio	Socio-economic status	Number/Ratio	Marital status	Number/Ratio
24-33	4(8%)	11	4(8%)	Lower	37(74%)	married	43(86%)
34-43	9(18%)	12	10(20%)	Middle	11(22%)	Widow	6(12%)
44-53	12(24%)	13	23(46%)	Upper	2(4%)	divorced	2(4%)
54-63	15(30%)	14	10(20%)				
Above 64	10(20%)	15	3(6%)				
Total (N)	50 (100%)	Total (N)	50 (100%)	Total (N)	50 (100%)	Total (N)	50 (100%)

Note: Age category based on WHO classification**.**
Abbreviation: N, Number**.**

Table 2: Demographic characteristics of breast cancer patients

Age Years (at the time of diagnosis)		Frequency and %	Menarche Age (years)	Number and %	Occupation	Number and %	Marital status	Number and %
	20-29	2(1.4%)	12	13(9%)	housewife	106(73.6%)	married	129(89.6%)
	30-39	23(16%)	13	55(38.2%)	Job holder and others	38(26.4%)	widow and divorced	15(10.4%)
	40-49	54(37.5%)	14	50(34.7%)				
	50-59	41(28.5%)	15	11(7.6%)				
	60- 69	18(12.5%)	16	15(10.4%)				
	70-79	6(4.2%)						
	Total (N)	144(100%)	Total (N)	144(100%)		144(100%)		144(100%)

Table 3: Paired sample T-test comparison of Hematological and biochemical (RBC, MCV, MCH, Blood urea) profile of breast cancer patients

Parameters		Mean	Std. Deviation	95% Confidence Interval of the Difference		Sig. (2-tailed)
				Lower	Upper	
Pair 1	**RBC Counts (10^6/ul)_A - RBC Counts (10^6/ul)_B**	0.16634	0.67168	.03374	.29893	0.01*
Pair 2	**MCV (fl)_A - MCV (fl)_B**	1.10297	5.29606	-2.14848	-.05746	0.03*
Pair 3	**MCH (pg)_A - MCH (pg)_B**	-.45347	2.22075	-0.89187	-.01506	0.04*
Pair 4	**Blood Urea (mg/dl)_A - Blood Urea (mg/dl)B**	-3.27644	10.87231	-5.42277	-1.13011	0.003*

A = pre-chemotherapy blood profile of breast cancer patients
B= post-chemotherapy blood profile of breast cancer patients
*= significant value ($p<0.05$)

Table 4. Paired sample T-test comparison of Hematological and biochemical (MCV and MCHC) profile of ovarian cancer patients#

	Parameters	Mean	Std. Deviation	95% Confidence Interval of the Difference		Sig. (2-tailed)
				Lower	Upper	
Pair 2	**MCV (fl)_A - MCV (fl)_B**	-6.3058	10.54402	-9.98486	-2.62690	0.001*
Pair 3	**MCHC (g/dL)_A – MCHC (G/dL)_B**	-1.2492	1.69947	-1.84224	-0.65629	0.004*