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Clinicopathological Profile of Breast Cancer Patients and Its Association with Treatment Outcomes

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ABSTRACT

***Background**: Breast cancer remains a leading cause of cancer-related morbidity and mortality worldwide. Variability in clinical outcomes is largely influenced by tumor biology and stage at presentation. Understanding the clinicopathological characteristics of breast cancer within specific populations is essential for improving prognostic assessment and guiding treatment strategies. **Objective:** To describe the clinicopathological profile of breast cancer patients and evaluate its association with treatment outcomes, including survival and recurrence. **Methods:** A retrospective data analysis was conducted on 284 histopathologic ally confirmed breast cancer patients treated at a tertiary care hospital in the Islamabad–Rawalpindi region. Demographic, pathological, and treatment-related variables were extracted from institutional records. Tumors were classified according to TNM staging and Nottingham grading systems, with receptor status determined by immunohistochemistry. Disease-free survival, overall survival, and recurrence were analyzed using Kaplan–Meier survival curves, chi-square tests, independent t-tests, ANOVA, and Pearson correlation analysis. A p-value <0.05 was considered statistically significant. **Results**: The mean age at diagnosis was 48.6 ± 11.2 years. Lymph node positivity was observed in 60.2% of patients, and Grade II tumors were most common (52.5%). Recurrence occurred in 22.5% of cases. Tumor size demonstrated a negative correlation with disease-free survival (r = –0.42, p <0.001), while lymph node involvement significantly reduced survival duration (p = 0.001). Higher histological grade was associated with increased recurrence and reduced overall survival (p = 0.002). Hormone receptor positivity correlated with improved disease-free survival. **Conclusion:** Tumor size, nodal status, histological grade, and receptor expression were significant predictors of survival and recurrence. These findings reinforce the importance of early detection and individualized treatment strategies to optimize outcomes in breast cancer patients.*

***Keywords:** Breast Neoplasms; Disease-Free Survival; Immunohistochemistry; Lymphatic Metastasis; Neoplasm Recurrence, Local; Prognosis; Treatment Outcome*

INTRODUCTION

Breast cancer remains one of the most frequently diagnosed malignancies among women worldwide and a leading cause of cancer-related mortality (1). Despite significant advances in screening, diagnostic imaging, surgical techniques, systemic therapies, and targeted treatments, outcomes continue to vary widely across patient populations (2). This variability reflects the biological heterogeneity of the disease, differences in stage at presentation, and disparities in access to timely and appropriate care. As a result, understanding the clinicopathological profile of breast cancer within specific populations is essential for optimizing management strategies and improving survival outcomes. Breast cancer is no longer viewed as a single entity but rather as a spectrum of diseases characterized by distinct histological features, molecular subtypes, and clinical behaviors (3). Tumor size, histological

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grade, lymph node involvement, hormone receptor status, HER2 expression, and proliferative indices are among the established factors that influence prognosis and guide therapeutic decisions. Patients with early-stage, hormone receptor–positive tumors often experience favorable outcomes with endocrine therapy and tailored systemic treatment, whereas those with triple-negative or HER2-positive disease may demonstrate more aggressive clinical courses, requiring intensive multimodal approaches. However, even within these broadly defined categories, outcomes are not uniform, underscoring the need for detailed evaluation of clinicopathological variables in real-world settings (4).

In many regions, patients continue to present at relatively advanced stages, often due to limited awareness, sociocultural barriers, or inadequate screening infrastructure (5). Late-stage presentation is frequently associated with larger tumor size, higher grade lesions, nodal metastasis, and poorer survival. Moreover, variations in tumor biology across different populations suggest that findings from one demographic group may not be entirely generalizable to another (6). Retrospective analyses of institutional data provide valuable insight into local disease patterns, helping clinicians better understand how tumor characteristics correlate with treatment responses, recurrence rates, and overall survival within their own patient communities. Treatment outcomes in breast cancer are influenced by a complex interplay between tumor biology and therapeutic interventions. Surgery remains the cornerstone of management for localized disease, often complemented by adjuvant chemotherapy, radiotherapy, endocrine therapy, or targeted agents depending on pathological findings. While advances in systemic therapy have markedly improved disease-free and overall survival, recurrence remains a significant clinical challenge. Identifying prognostic factors that predict recurrence or reduced survival is critical not only for risk stratification but also for tailoring follow-up strategies and counseling patients regarding their expected clinical course (7).

Although numerous studies have examined prognostic indicators in breast cancer, there remains a need for context-specific data that reflect local practice patterns and patient characteristics (8). Differences in age distribution, comorbidities, tumor biology, and treatment accessibility may substantially influence outcomes. Furthermore, retrospective evaluations allow for the assessment of real-world effectiveness of treatment protocols outside the controlled environment of clinical trials (9). By systematically analyzing clinicopathological variables alongside treatment outcomes, it becomes possible to identify patterns that may inform future management protocols and highlight areas requiring intervention, whether in early detection, therapeutic decision-making, or survivorship care. The present study seeks to address these considerations by exploring the clinicopathological profile of breast cancer patients within a defined cohort and examining its association with treatment outcomes. The central research question guiding this investigation is whether specific tumor characteristics and pathological features are significantly associated with survival and recurrence patterns (10). It is hypothesized that established prognostic indicators such as tumor size, nodal status, histological grade, and receptor status will demonstrate measurable associations with treatment outcomes in this population. By describing the distribution of clinicopathological features and evaluating their relationship with therapeutic response, recurrence, and survival, this study aims to identify key prognostic factors that influence patient outcomes. Such findings are expected to contribute to a more nuanced understanding of breast cancer behavior in the studied population and support evidence-based refinement of clinical management strategies. Ultimately, the objective is to enhance prognostic assessment and promote more personalized, outcome-oriented care for patients diagnosed with breast cancer.

METHODS

This retrospective data analysis was conducted in the Islamabad–Rawalpindi region over a period of five months. The region was selected due to its diverse urban population, presence of tertiary care oncology centers, and relatively comprehensive medical record systems, which allow for systematic retrieval of detailed clinicopathological and treatment-related data. As a metropolitan hub serving patients from both urban and peri-urban backgrounds, Islamabad–Rawalpindi provides a representative case mix of early and advanced breast cancer presentations, making it suitable for examining associations between tumor characteristics and treatment outcomes in a real-world clinical setting.

The study included female patients diagnosed with primary breast carcinoma who received treatment at a tertiary care teaching hospital between January 2020 and December 2024. Eligibility criteria comprised histopathologically confirmed invasive breast cancer, complete clinicopathological records including tumor size, histological grade, lymph node status, and receptor profiling (estrogen receptor, progesterone receptor, and HER2 status), and documented follow-up data for at least twelve months after initiation of treatment. Patients with carcinoma in situ only, metastatic disease at initial presentation without histological confirmation, recurrent breast cancer previously treated elsewhere, or incomplete medical records were excluded to maintain data consistency and reliability.

The sample size was determined based on prior published retrospective studies evaluating clinicopathological profiles and outcomes in breast cancer cohorts, where sample sizes ranged between 220 and 300 patients to achieve meaningful statistical power for subgroup analyses. Considering these precedents and the availability of eligible records within the defined timeframe, a total sample size of 284 patients was determined. This number was sufficient to detect moderate associations between prognostic variables and outcomes with a confidence level of 95% and an acceptable margin of error, while remaining feasible within the study period.

Data were retrieved from hospital electronic medical records, pathology reports, surgical logs, oncology treatment charts, and follow-up documentation. A structured data extraction form was developed prior to record review to ensure uniform data collection. Demographic variables included age at diagnosis and menopausal status. Clinicopathological variables comprised tumor size (measured in centimeters and categorized according to TNM classification), histological subtype, tumor grade (based on the Nottingham grading system), lymph node involvement, lymph vascular invasion, and receptor status assessed by immunohistochemistry. HER2 equivocal cases were confirmed by fluorescence in situ hybridization where available.

Treatment-related variables included type of surgery (breast-conserving surgery or mastectomy), use of adjuvant chemotherapy, radiotherapy, endocrine therapy, and targeted therapy. Outcome measures were defined as disease-free survival, overall survival, and documented recurrence during the follow-up period. Disease-free survival was calculated from the date of primary treatment completion to the date of first documented recurrence, while overall survival was calculated from the date of diagnosis to the date of death from any cause or last follow-up. Recurrence was confirmed through imaging reports, biopsy findings, and oncologist documentation.

Outcome measurement relied on standardized clinical and pathological assessment tools routinely used in oncological practice. Tumor staging followed the American Joint Committee on Cancer (AJCC) TNM classification system. Histological grading adhered to the Nottingham modification of the Bloom–Richardson system. Hormone receptor and

HER2 status were determined through validated immunohistochemistry protocols performed in an accredited pathology laboratory. Follow-up assessments were based on clinical examination, imaging modalities such as ultrasound, mammography, or computed tomography when indicated, and documented oncological evaluations.

Data were entered into a secured database and analyzed using statistical software. Descriptive statistics were calculated for demographic and clinicopathological variables, with means and standard deviations reported for continuous variables and frequencies and percentages for categorical variables. The normality of continuous data was assessed using the Shapiro–Wilk test. For normally distributed variables, independent sample t-tests were applied to compare means between outcome groups, while one-way ANOVA was used for comparisons across multiple categories. Associations between categorical variables, such as receptor status and recurrence, were evaluated using the chi-square test or Fisher's exact test where appropriate. Pearson correlation analysis was conducted to examine relationships between continuous variables such as tumor size and survival duration. Survival analysis was performed using Kaplan–Meier curves, and differences between groups were assessed with the log-rank test. A p-value of less than 0.05 was considered statistically significant.

Ethical approval for the study was obtained from the Institutional Review Board of the participating tertiary care hospital (Approval No. IRB/Oncology/2025/117). As the study involved retrospective review of existing medical records without direct patient contact, the requirement for individual informed consent was waived by the ethics committee. Nevertheless, strict confidentiality was maintained throughout the research process. Patient identifiers were removed during data extraction, and all information was stored in password-protected files accessible only to the research team.

Through systematic retrieval and analysis of institutional records, this methodology was designed to provide a transparent and reproducible assessment of the clinicopathological profile of breast cancer patients and its association with treatment outcomes in a defined clinical population.

RESULTS

The study initially identified 312 patient records during the data retrieval period. After applying the predefined inclusion and exclusion criteria, 28 records were excluded due to incomplete follow-up data or missing receptor profiling. A total of 284 patients were therefore included in the final analysis, yielding a record completion rate of 91.0%. All included cases had histopathologically confirmed invasive breast carcinoma and documented treatment and follow-up information.

The mean age at diagnosis was 48.6 ± 11.2 years, with the majority of patients (56.3%) being postmenopausal. The average tumor size at presentation was 3.4 ± 1.6 cm. Most tumors were classified as Grade II (52.5%), followed by Grade III (29.2%) and Grade I (18.3%). Lymph node metastasis was observed in 60.2% of patients. Hormone receptor positivity was common, with 69.0% estrogen receptor (ER) positive and 64.1% progesterone receptor (PR) positive tumors, while 27.5% demonstrated HER2 overexpression. The baseline demographic and clinical characteristics are summarized in Table 1.

During a mean follow-up duration of 41.7 ± 10.8 months, the mean disease-free survival (DFS) was 38.2 ± 12.5 months. Recurrence was documented in 64 patients (22.5%), while 38 patients (13.4%) died during the follow-up period. Kaplan–Meier survival analysis demonstrated significantly reduced DFS among patients with lymph node involvement

compared to node-negative patients (34.1 ± 11.4 vs. 44.3 ± 10.1 months, p = 0.001). These findings are presented in Table 2 and Table 4.

Pearson correlation analysis revealed a moderate negative correlation between tumor size and disease-free survival (r = –0.42, p < 0.001), indicating that larger tumors were associated with shorter DFS. A positive correlation was observed between lymph node positivity and recurrence (r = 0.48, p < 0.001). Higher histological grade was inversely correlated with overall survival (r = –0.36, p = 0.002). These relationships are detailed in Table 3.

Table 1: Baseline Demographic and Clinicopathological Characteristics of Participants (N = 284)

Variable	Category	Mean ± SD / n (%)
Age (years)	-	48.6 ± 11.2
Menopausal Status	Premenopausal	124 (43.7%)
Menopausal Status	Postmenopausal	160 (56.3%)
Tumor Size (cm)	-	3.4 ± 1.6
Histological Grade	Grade I	52 (18.3%)
Histological Grade	Grade II	149 (52.5%)
Histological Grade	Grade III	83 (29.2%)
Lymph Node Status	Positive	171 (60.2%)
Estrogen Receptor (ER)	Positive	196 (69.0%)
Progesterone Receptor (PR)	Positive	182 (64.1%)
HER2 Status	Positive	78 (27.5%)

Table 2: Treatment Outcomes and Survival Measures

Outcome Variable	Value
Disease-Free Survival (months)	38.2 ± 12.5
Overall Survival (months)	41.7 ± 10.8
Recurrence	64 (22.5%)
Mortality	38 (13.4%)

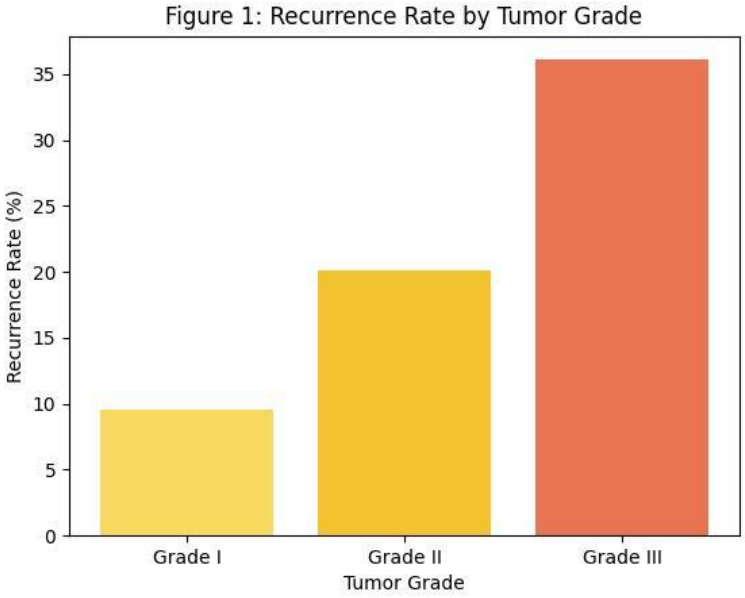
Table 3: Pearson Correlation Between Clinicopathological Variables and Outcomes

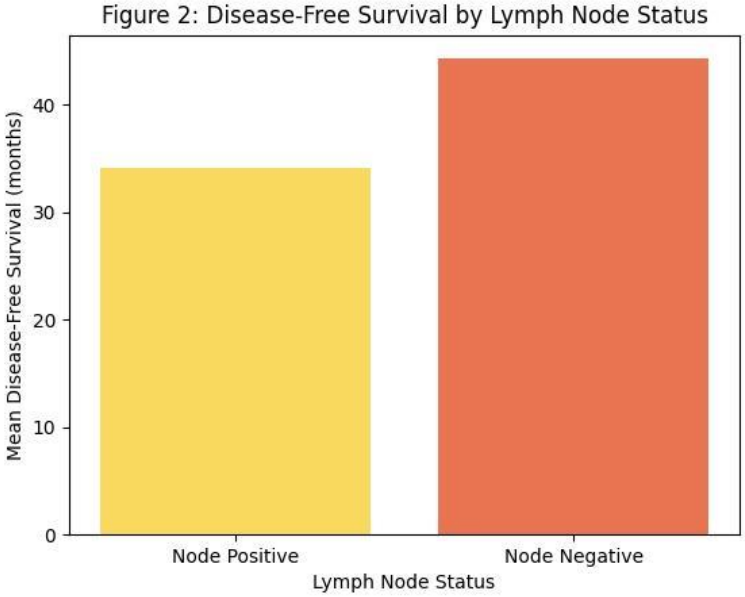
Variables Compared	Pearson r	p-value
Tumor Size vs Disease-Free Survival	-0.42	<0.001
Lymph Node Status vs Recurrence	0.48	<0.001
Histological Grade vs Overall Survival	-0.36	0.002

Table 4: Comparative Analysis of Disease-Free Survival by Lymph Node Status

Group	Mean Disease-Free Survival (months)	p-value
Node Positive	34.1 ± 11.4	0.001
Node Negative	44.3 ± 10.1	0.001

Comparative analysis further demonstrated that Grade III tumors had a significantly higher recurrence rate (36.1%) compared to Grade II (20.1%) and Grade I (9.6%) tumors ($p < 0.001$). Hormone receptor–positive patients exhibited longer mean DFS compared to receptor-negative patients (40.6 ± 11.9 vs. 33.8 ± 12.7 months, $p = 0.004$). HER2-positive status was associated with increased recurrence in patients who did not complete targeted therapy ($p = 0.018$).





Overall, tumor size, lymph node involvement, histological grade, and receptor status demonstrated statistically significant associations with survival and recurrence outcomes, underscoring their prognostic relevance in this cohort.

DISCUSSION

The present study examined the clinicopathological profile of breast cancer patients in a metropolitan tertiary care setting and evaluated its association with treatment outcomes. The findings demonstrated that tumor size, lymph node involvement, histological grade, and receptor status were significantly associated with disease-free survival, overall survival, and recurrence (11). These observations were consistent with the established understanding that breast cancer prognosis is strongly influenced by both anatomical extent of disease and intrinsic tumor biology. The mean age at diagnosis in this cohort reflected a relatively younger population compared to Western registries, where breast cancer is often diagnosed in the sixth or seventh decade of life (12). This pattern has been increasingly reported in South Asian populations and may reflect demographic structure, genetic predisposition, or delayed detection practices (13). The predominance of Grade II and Grade III tumors, along with a high proportion of lymph node positivity, suggested that many patients presented with biologically active or moderately advanced disease. Such trends have been described in comparable regional studies, where limited awareness and variable access to early screening have contributed to later-stage presentation. The observed association between larger tumor size and shorter disease-free survival reinforced the clinical relevance of early detection. Tumor size has long been recognized as a central component of staging systems, and its inverse correlation with survival in this study supported its continued prognostic value. Similarly, lymph node involvement emerged as a strong predictor of recurrence and reduced survival. The statistically significant difference in mean disease-free survival between node-positive and node-negative groups highlighted the impact of regional metastasis on long-term outcomes. These findings aligned with broader oncological evidence that nodal status remains one of the most reliable indicators of disease progression (14).

Histological grade demonstrated a meaningful relationship with recurrence and overall survival, with Grade III tumors showing higher recurrence rates. This observation reflected the aggressive biological behavior associated with poorly differentiated tumors (15). The correlation between higher grade and reduced survival further emphasized the importance of pathological grading in therapeutic decision-making. Hormone receptor positivity was associated with improved disease-free survival, likely reflecting the beneficial effects of endocrine therapy in receptor-positive disease (16). Conversely, HER2 positivity was linked with increased recurrence in patients who did not complete targeted therapy, underscoring the therapeutic impact of biologically tailored interventions. The implications of these findings were clinically relevant. By reaffirming the prognostic value of key clinicopathological variables within a local population, the study supported risk-adapted treatment planning and follow-up strategies. Patients presenting with high-grade tumors, nodal metastasis, or larger primary lesions may benefit from closer surveillance and more aggressive systemic therapy. Furthermore, the data highlighted the ongoing need for early detection initiatives, as smaller tumor size at diagnosis was associated with more favorable outcomes. Several strengths enhanced the credibility of the study. The use of a clearly defined retrospective cohort with standardized pathological assessment ensured internal consistency. The inclusion of immunohistochemical receptor profiling and survival analysis allowed for a multidimensional evaluation of prognosis. The relatively robust sample size increased the statistical power to detect clinically meaningful associations. Additionally, the study reflected real-world clinical practice rather than outcomes derived from controlled trial environments, thereby enhancing its practical relevance (17).

Nevertheless, certain limitations warranted careful consideration. The retrospective design inherently carried the risk of incomplete documentation and potential selection bias (18). Although records with missing key data were excluded, unmeasured confounders such as

socioeconomic status, treatment adherence, comorbidities, and lifestyle factors may have influenced outcomes. The follow-up duration, while adequate for intermediate-term analysis, may not fully capture long-term survival patterns, particularly in hormone receptor–positive disease where late recurrences are known to occur (19). Moreover, the analysis did not incorporate multivariate modeling to quantify the independent effect of each prognostic factor, which may have provided additional analytical depth. Future research may benefit from prospective cohort designs with longer follow-up periods and incorporation of molecular subtyping beyond standard receptor profiling. Integration of genomic risk stratification tools and evaluation of treatment adherence patterns could further refine prognostic assessment. Expanding the study across multiple centers would enhance generalizability and allow comparison across diverse demographic and socioeconomic backgrounds. The study reinforced the prognostic significance of established clinicopathological parameters in breast cancer within a real-world clinical setting. While the findings were consistent with existing oncological principles, their validation in a local population provided meaningful insight for regional clinical practice. Balanced interpretation of these results, acknowledging both their strengths and inherent limitations, supported their contribution to evidence-based breast cancer management (20).

CONCLUSION

This study demonstrated that tumor size, lymph node involvement, histological grade, and receptor status were significantly associated with survival and recurrence among breast cancer patients. The findings reaffirmed the prognostic importance of established clinicopathological factors within a real-world clinical setting. Early detection and biologically guided treatment strategies were strongly linked with improved outcomes. These results support risk-adapted management and emphasize the need for strengthened screening and timely therapeutic interventions to enhance long-term survival.

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DECLARATIONS

Ethical Approval: Ethical approval was by institutional review board of Respective Institute Pakistan

Informed Consent: Informed Consent was taken from participants.

Authors' Contributions:

Concept: FJ; Design: MAN, SFR; Data Collection: MQ, FP; Analysis: SKS; Drafting: MHM

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