DOI: https://doi.org/10.54393/pjhs.v7i10.3211

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 7, Issue 10 (October 2026)



OPEN ACCESS
Check for updates

Original Article

Radio-Pathological Concordance in Ultrasound-Guided Core Needle Biopsies of Breast Lesions: A Retrospective Study

Uzma Azmat[1*], Sadaf Nasir[2] and Abdul Qayoom Rakhshani[1]

[1]Department of Radiology, Memon Medical Institute Hospital, Karachi, Pakistan
[2]Department of Radiology, Jinnah Postgraduate Medical Center, Karachi, Pakistan

ARTICLE INFO

Keywords:
Ultrasound Guided Core Needle Biopsy, Breast Lesions, Radio-Pathological, Concordance, Discordance

How to Cite:
Azmat, U., Nasir, S., & Rakhshani, A. Q. (2026). Radio-Pathological Concordance in Ultrasound-Guided Core Needle Biopsies of Breast Lesions: A Retrospective Study: Radio-Pathological Concordance in Ultrasound-Guided Core Needle Biopsies of Breast Lesions. Pakistan Journal of Health Sciences, 7(10), 101-105. https://doi.org/10.54393/pjhs.v7i10.3211

***Corresponding Author:**
Uzma Azmat
Department of Radiology, Memon Medical Institute Hospital, Karachi, Pakistan
azmat.radiologist@gmail.com

Received Date: 11th August, 2025
1st Revision Received: 3rd December, 2025
2nd Revision Received: 2nd April, 2026
3rd Revision Received: 15th May, 2026
Acceptance Date: 22nd May, 2026
Published Date: 31st October, 2026

ABSTRACT

Breast cancer is the leading malignancy among women in Pakistan, often presenting at advanced stages. Accurate, minimally invasive diagnostic methods such as ultrasound-guided core needle biopsy (CNB) are critical in optimizing care and resource allocation. **Objectives:** To see the diagnostic accuracy of ultrasound-guided core needle biopsy (CNB) in breast lesions, assess radio-pathological concordance and discordance, and improve standards of clinical care and resource utilization. **Methods:** This retrospective study included female outpatients and walk-in patients aged 15–80 years who underwent ultrasound-guided CNB for breast lesions at the Department of Radiology, Memon Medical Institute Hospital, Karachi, between 1 August 2024 and 31 July 2025. Data were retrieved from the electronic health records and analyzed for demographic characteristics, lesion features, histopathological findings, and radio-pathological concordance. Data were analyzed using RStudio. **Results:** One hundred and eleven ultrasound-guided core-needle biopsies were analyzed (mean age 44.7 ± 14.5 years). Lesions were almost evenly split between the right (50.5%) and left (49.5%) breasts; 88 lesions (79.3%) measured >2 cm. Histopathology showed 55 benign (49.5%), 46 malignant (41.4%), and 10 inadequate (9%) cores. Among the 101 cases with complete radiological–histopathological pairing, concordance was 89.1% for benign lesions and 95.7% for malignant lesions, resulting in an overall concordance of 92.1% (sensitivity, 95.7%; specificity, 89.1%). **Conclusions:** Ultrasound-guided core needle biopsy is an indispensable, effective, less invasive, and cost-effective tool for accurate and early diagnosis, significantly reducing the need for unnecessary surgical interventions; excisional or incisional biopsy for diagnosis, while providing crucial histological and molecular data for treatment decisions.

INTRODUCTION

Breast cancer generated an estimated 2.30 million new cases and 670,000 deaths worldwide in 2022, making it the most frequently diagnosed malignancy in women and the fourth - leading cause of cancer death overall [1]. Incidence has climbed 17% in the past decade, with half of cases arising in women who lack recognised risk factors beyond sex and age [1]. Asia now shoulders 43% of the global caseload (≈ 986,000 cases) and 47% of deaths [2], reflecting rapid demographic transition and limited screening coverage across many low- and middle-income settings. Pakistan bears the region's heaviest burden. GLOBOCAN 2022 estimates attribute 25,928 new breast cancers (28.7% of all female malignancies) and 13,725 deaths (11.7% of female cancer deaths) to the country each year [3]. Age-standardized incidence rates in Karachi almost doubled from 24.7 per 100,000 in 2004 to 45.4 per 100,000 in 2015, increasing on average 5.4% annually [3]. Consequently, one in nine Pakistani women is projected to develop breast cancer during her lifetime, and up to 60% still present with stage III–IV disease; a pattern that

Copyright© 2026 The Authors. Published by CrossLinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0)

DOI: https://doi.org/10.54393/pjhs.v7i10.3211

underscores the urgent need for accurate, minimally invasive diagnostic pathways accessible within constrained health-care budgets [3, 4]. Ultrasound-guided core needle biopsy (CNB) has replaced fine-needle aspiration cytology (FNAC) as the preferred tissue-sampling technique for image-detected breast lesions [5, 6]. A 2024 meta-analysis pooling >4500 lesions reported a sensitivity of 94% and a specificity of 100% for CNB, outperforming FNAC (85% sensitivity, 93% specificity) while providing architecture for histological grading and receptor profiling [5, 6]. Compared with open surgical biopsy, routine first-line CNB can cut diagnostic expenditure by 56% and avert roughly US $1.5 billion in excess costs annually in high-volume health systems [7, 8]. Current breast-imaging and oncology guidelines recommend image-guided tissue sampling for suspicious breast lesions and emphasize radiological–pathological correlation before definitive management [9-11]. This study remains pivotal for verifying that local practice meets those standards. A 2023 tertiary-centre study from Karachi recorded overall radio-pathological concordance in 91.6% of 453 CNBs, with discordant benign under-calls in 7.7% and malignant over-calls in 9.9% [12]. International systematic reviews cite false-negative rates below 1% for MRI-guided biopsies and upgrade risks of 15–53% for high-risk B3 lesions, underscoring the necessity of systematic concordance assessment and targeted repeat sampling where discrepancies arise [13, 14]. Regular studies also expose gaps in operator training, optimize clip placement protocols, and inform resource allocation within constrained oncology services.

Against this backdrop, the current study undertook a comprehensive review of ultrasound-guided CNB at Memon Medical Institute Hospital, Karachi. This study aims to quantify radio-pathological concordance and discordance, to establish the sensitivity, specificity, and false-negative rates of CNB in a high-incidence population, and to identify procedural or interpretative factors amenable to quality improvement. By aligning local performance metrics with contemporary ACR and NCCN benchmarks, the study aimed to enhance diagnostic accuracy, minimize unnecessary surgery, and support equitable, evidence-based breast cancer care in Pakistan.

METHODS

This single-centre retrospective study was conducted in the Department of Radiology, Memon Medical Institute Hospital, Karachi, Pakistan, from 1 August 2024 to 31 July 2025. This study was approved by the Institutional Review Board of Memon Medical Institute Hospital (Ref: IRB/MMIH/2024/38, dated 5 June 2024). Data were collected from August 2023 to May 2024. All consecutive ultrasound-guided CNBs of breast lesions performed between 1 August 2024 and 31 July 2025 were screened for inclusion. The study was conducted in accordance with the Declaration of Helsinki and institutional ethical guidelines, ensuring data confidentiality and patient privacy. All patient identifiers were anonymised before analysis. As the study utilized routinely collected clinical data, the institutional review board waived the requirement for individual informed consent. Eligible participants were women aged 15–80 years presenting as outpatients or walk-in cases, who underwent ultrasound-guided CNB for a breast lesion and had an available histopathology report. Exclusion criteria included inpatient procedures, known breast cancer diagnoses, cases lacking follow-up histology, or those where no lesion was identified on imaging. Participants were recruited using a consecutive sampling technique. The sample size was calculated using the formula for a single population proportion: $n=Z2 \cdot p \cdot (1-p)/d2$ [15], based on a previously reported radiopathological concordance rate of 91.6% from a local audit [12]. With a 95% confidence interval and a margin of error of 5.5%, the required sample size was 98. To account for potential missing or inadequate data, a 15% inflation was applied, resulting in a final target sample size of approximately 113 biopsies. Data were retrieved from the HMIS of Memon Medical Institute Hospital, and biopsy samples were processed in the Memon Medical Institute Histopathology Laboratory, while ultrasound images were reviewed using the Picture Archiving and Communication System (PACS). All biopsies were performed or directly supervised by a consultant radiologist. Procedures were conducted using a GE Logiq E9 ultrasound machine with a high-frequency (9–15 MHz) linear transducer. After standard skin preparation and local anesthesia (1% lidocaine), a Bard Magnum reusable biopsy gun with Bard Mission 14G or 16G needles was used to obtain 3–5 core samples via a 2–3 mm incision under real-time ultrasound guidance. Manual compression and sterile dressing were applied post-procedure. Biopsy samples were preserved in formalin and processed at the institution's pathology laboratory. Sections were stained with hematoxylin and eosin (H&E) and interpreted by board-certified histopathologists. Lesions were categorized as benign, malignant, or inadequate based on diagnostic sufficiency, architectural features, and cellular morphology, following the WHO Classification of Breast Tumours, 5th Edition (2019) [16]. Demographic details, including patient age, were extracted from HMIS. Other variables included lesion laterality (right/left), lesion size, histopathological category, and radio-pathological concordance status. BI-RADS category was not consistently available in the retrospective dataset and therefore could not be included in the analysis.

Copyright© 2026 The Authors. Published by CrossLinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0)

DOI: https://doi.org/10.54393/pjhs.v7i10.3211

Statistical analysis was carried out in R Studio. Continuous data (age) are summarized as mean ± SD. Categorical data (lesion laterality, size category, histopathology class, concordance status) are described as frequencies and percentages. Diagnostic performance indices, i.e., sensitivity, specificity, and overall diagnostic accuracy, were calculated using ultrasound-guided CNB histopathology as the index test, and final histopathological diagnosis (from surgical excision or clinical consensus) as the reference standard. A 2×2 contingency table was used to classify true positives, false positives, true negatives, and false negatives.. Discordant-to-concordant ratios were computed separately for benign and malignant groups by dividing the number of discordant cases by the number of concordant cases within each group. Fisher's exact test was used to compare discordance rates between benign and malignant categories, with $p<0.05$ considered statistically significant.

RESULTS

A total of 113 breast CNBs were initially identified during the study period. Two cases were excluded due to incomplete data, resulting in 111 ultrasound-guided CNBs being analyzed. The mean age of patients was 44.7 ± 14.5 years (range: 16–80 years). The youngest patient was 16, and the oldest was 80. Lesions were almost equally distributed between the right breast (56 cases; 50.5%) and the left breast (55 cases; 49.5%). A majority of lesions (88 cases; 79.3%) measured greater than 2 cm. Histopathologically, 55 lesions (49.5%) were benign, 46 (41.4%) were malignant, and 10 (9.0%) yielded inadequate samples (Table 1).

Table 1: Clinical Characteristics of the Cases (n=111)

Characteristics	n (%)
Lesion Site	
Right	56 (50.5%)
Left	55 (49.5%)
Lesion Size	
≤2 cm	12 (10.8%)
>2–5 cm	88 (79.3%)
>5–8 cm	1 (0.9%)
Inadequate/Not Recorded	10 (9.0%)
Histopathological Finding	
Benign	55 (49.5%)
Malignant	46 (41.4%)
Inadequate Sample	10 (9.0%)

In a total of 101 paired cytology–histopathology specimens, overall concordance was 93/101 (92.1%) and overall discordance was 8/101 (7.9%). When stratified by histopathological diagnosis, benign lesions (n=55) showed concordance in 89.1% of cases and discordance in 10.9%, yielding a discordant - to - concordant ratio of 0.122. Malignant lesions (n=46) demonstrated higher concordance of 95.7% and lower discordance of 4.3%, with a discordant - to - concordant ratio of 0.045. Using histopathology as the reference standard, cytology achieved a sensitivity of 95.7% and a specificity of 89.1%, resulting in an overall diagnostic accuracy of 92.1%. Fisher's exact test comparing the frequency of discordant results between the benign and malignant groups did not reach statistical significance ($p=0.285$), indicating that the likelihood of cytology–histology disagreement was similar regardless of underlying lesion type (Table 2).

Table 2: Concordance and Discordance of Cytology vs Histopathology (n=101)

Histopathology	n	Concordant	Discordant	Discordant: Concordant
Benign	55	49 (89.1%)	6 (10.9%)	0.122
Malignant	46	44 (95.7%)	2 (4.3%)	0.045
Overall	101	93	8	0.086

values shown as n (%)

The most common benign diagnosis was fibroepithelial lesion (n=25), followed by chronic inflammation (n=14). Among malignant cases, invasive ductal carcinoma grade II predominated (n=39), consistent with prior local studies (Figure 1).

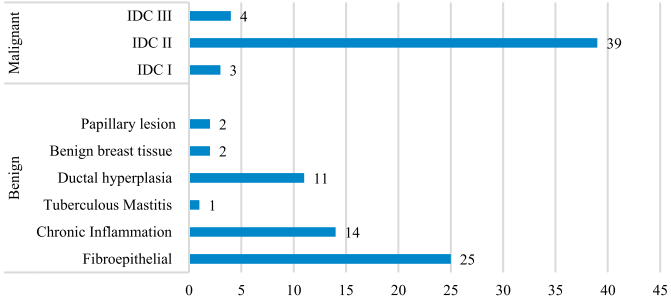


Figure 1: Frequency of Histopathological Diagnosis of Biopsy-Proven Benign and Malignant Breast Lesions (n=101)

DISCUSSION

This study reaffirms that ultrasound-guided CNB remains the optimal tissue-sampling technique for image-detected breast lesions in low- and middle-income environments. Radiological–pathological concordance was 92.1% in the present study. This finding supports the importance of systematic radiological–pathological correlation in evaluating the diagnostic adequacy of image-guided breast biopsy. [17, 18]. Concordance was higher for malignant lesions (95.7%) than for benign ones (89.1%), yielding a false-negative rate of 10.9% and a false-positive rate of 4.3%. Our inadequate sample rate (9%) met the international quality target of <10% [17]. The 10.9% false-negative rate highlights the importance of careful radiological–pathological correlation. Discordant cases should undergo review, with repeat biopsy or surgical excision considered when clinically indicated. Inadequate samples may also require repeat sampling to minimize the

Copyright© 2026 The Authors. Published by CrossLinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0)

DOI: https://doi.org/10.54393/pjhs.v7i10.3211

risk of missed malignancy. The distribution of histological diagnoses, particularly the predominance of invasive ductal carcinoma (IDC) grade II, closely mirrors other regional cohorts [12]. Furthermore, using histopathology as the reference standard, cytology achieved 95.7% sensitivity, 89.1% specificity, and 92.1% overall diagnostic accuracy; the likelihood of discordance did not differ significantly between benign and malignant strata (p=0.285). These figures consolidate CNB's reliability in routine practice. Two recent systematic reviews clarify why CNB is now preferred to FNAC. A meta-analysis of 1802 women showed a pooled sensitivity of 87% (95% CI 84–88%) and specificity of 98% (96–99%) for CNB, versus 74% (72–77%) and 96% (94–98%) for FNAC [19]. Another meta-analysis focusing on palpable lumps reported even wider performance gaps: pooled sensitivity for FNAC ranged from 35% to 96.6%, whereas CNB ranged from 82.9% to 100%; FNAC specificity varied between 48% and 100%, compared with 86% to 100% for CNB [20]. Diagnostic accuracy showed the same pattern (FNAC 71.4–96.6% vs CNB 82.8–100%). Our concordance figure (92.1%) comfortably overlaps the upper end of those CNB ranges and aligns with the 91.6% reported in a larger Karachi study [12]. Mean patient age (44.7 years) of the current study aligns with previous research indicating that breast cancer commonly affects middle-aged women in Pakistan, though cases in younger and older age groups were also observed [12, 21]. The nearly equal distribution of breast lesions between the right (50.5%) and left (49.5%) breasts suggests no significant laterality preference, inconsistent with global trends [22]. In the current study, the majority (79.3%) of cases presented with lesions larger than 2 cm, reinforcing the need for timely diagnosis and intervention, as larger lesion size is often associated with an increased likelihood of malignancy. This study has several strengths. All procedures were conducted or supervised by consultant radiologists, and data collection was supported by a comprehensive digital infrastructure (HMIS, PACS). The study adhered to the STARD (Standards for Reporting Diagnostic Accuracy Studies) framework and maintained a structured record of discordant cases.

However, several limitations should be acknowledged. The retrospective, single-center design limits the generalizability of the findings and may introduce potential selection and information bias due to reliance on routinely collected clinical records. Additionally, the study included only ultrasound-guided core needle biopsies, excluding MRI- or stereotactic-guided techniques. The 10 inadequate biopsy samples (9.0%) were excluded from the concordance analysis, which may have resulted in an overestimation of the reported diagnostic accuracy. Furthermore, the use of core-biopsy histology rather than systematic surgical excision as an independent reference standard limited the accurate assessment of false-negative results and histological upgrade rates. In addition, the concordance estimate used for sample size calculation was derived from a previous audit conducted at the same institution, which may have introduced circularity and limited the independence of the assumed accuracy estimate. The absence of longitudinal follow-up also restricted the assessment of recurrence or subsequent treatment outcomes, particularly among patients with radiological–pathological discordance. Finally, BI-RADS categories were not consistently documented in the retrospective records, limiting the assessment of correlations between imaging characteristics and histopathological findings. Prospective multicenter studies with standardized BI-RADS documentation, systematic follow-up, and surgical correlation are warranted to further evaluate the diagnostic performance and clinical outcomes of ultrasound-guided CNB.

CONCLUSIONS

Ultrasound-guided CNB is a reliable and minimally invasive diagnostic tool for breast lesions, demonstrating high radiological–pathological concordance in this study. However, the observed discordance and inadequate sample rates highlight the importance of careful radiological–pathological correlation. Discordant cases should undergo multidisciplinary review, with repeat image-guided biopsy or surgical excision considered when clinically indicated, while inadequate samples may require repeat sampling.

Authors' Contribution

Conceptualization: UA
Methodology: UA, AQR
Formal analysis: YA, AQR
Writing and Drafting: UA, SN, AQR
Review and Editing: UA, SN, AQR

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflict of Interest

All the authors declare no conflict of interest.

Source of Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

REFERENCES

[1] Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I *et al.* Global Cancer Statistics 2022: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA: A Cancer Journal for Clinicians. 2024 May; 74(3): 229-63. doi: 10.3322/caac.21834.

Copyright© 2026 The Authors. Published by CrossLinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0)

DOI: https://doi.org/10.54393/pjhs.v7i10.3211

[2] Lim YX, Lim ZL, Ho PJ, Li J. Breast Cancer in Asia: Incidence, Mortality, Early Detection, Mammography Programs, and Risk-Based Screening Initiatives. Cancers. 2022 Aug; 14(17): 4218. doi: 10.3390/cancers14174218.

[3] Zaheer S and Yasmeen F. Historical Trends in Breast Cancer Presentation among Women in Pakistan from Join-Point Regression Analysis. Pakistan Journal of Medical Sciences. 2024 Jan; 40(1Part-I): 134. doi: 10.12669/pjms.40.1.7123.

[4] Fu M, Peng Z, Wu M, Lv D, Li Y, Lyu S. Current and Future Burden of Breast Cancer in Asia: A GLOBOCAN Data Analysis for 2022 and 2050. The Breast. 2025 Feb; 79: 103835. doi: 10.1016/j.breast.2024.103835.

[5] Verma P, Sharma R, Sharma N, Gulati A, Parashar A, Kaundal A. Fine-Needle Aspiration Cytology versus Core-Needle Biopsy for Breast Lesions: A Dilemma of Superiority Between the Two. Acta Cytologica. 2021 Sep; 65(5): 411-6. doi: 10.1159/000517005.

[6] Kwon Y and Lee MK. Diagnostic Performance and Safety of Ultrasound - Guided Core Needle Biopsy for Diagnosing Lymphoma: A Systematic Review and Meta - Analysis. Cancer Medicine. 2025 Jan; 14(1): e70414. doi: 10.1002/cam4.70414.

[7] Nields MW. Cost-Effectiveness of Image-Guided Core Needle Biopsy versus Surgery in Diagnosing Breast Cancer. Academic Radiology. 1996 Apr; 3: S138-40. doi: 10.1016/S1076-6332(96)80514-9.

[8] Liberman L, Feng TL, Dershaw DD, Morris EA, Abramson AF. US-Guided Core Breast Biopsy: Use and Cost-Effectiveness. Radiology. 1998 Sep; 208(3): 717-23. doi: 10.1148/radiology.208.3.9722851.

[9] Network NC. NCCN Clinical Practice Guidelines in Oncology: Breast Cancer (Version 3.2024). in Plymouth Meeting, PA: National Comprehensive Cancer Network. 2024.

[10] World Health Organization. Global Breast Cancer Initiative Implementation Framework: Assessing, Strengthening and Scaling-Up of Services for the Early Detection and Management of Breast Cancer. World Health Organization. 2023 Mar.

[11] Purysko AS, Tempany C, Macura KJ, Turkbey B, Rosenkrantz AB, Gupta RT *et al.* American College of Radiology Initiatives on Prostate Magnetic Resonance Imaging Quality. European Journal of Radiology. 2023 Aug; 165: 110937. doi: 10.1016/j.ejrad.2023.110937.

[12] Imtiaz S, Naz N, Walid A, Rahim A. Ultrasound Guided Core Needle Biopsy of Breast Lesions with Radio-Pathological Concordance/Discordance: A Medical Audit of Tertiary Care Breast Imaging Unit. Journal of the Society of Obstetricians and Gynaecologists of Pakistan. 2023 Apr; 13(1): 1-4.

[13] Harbhajanka A, Gilmore HL, Calhoun BC. High-Risk and Selected Benign Breast Lesions Diagnosed on Core Needle Biopsy: Evidence for and Against Immediate Surgical Excision. Modern Pathology. 2022 Nov; 35(11): 1500-8. doi: 10.1038/s41379-022-01092-w.

[14] Özcan BB, Yan J, Xi Y, Baydoun S, Scoggins ME, Doğan BE. Performance Benchmark Metrics and Clinicopathologic Outcomes of MRI-Guided Breast Biopsies: A Systematic Review and Meta-Analysis. European Journal of Breast Health. 2023 Jan; 19(1): 1. doi: 10.4274/ejbh.galenos.2022.2022-12-1.

[15] Lwanga SK, Lemeshow S, World Health Organization. Sample Size Determination in Health Studies: A Practical Manual. World Health Organization. 1991.

[16] Cserni G, Francz M, Járay B, Kálmán E, Kovács I, Krenács T *et al.* Pathological Diagnosis, Work-Up and Reporting of Breast Cancer 1st Central-Eastern European Professional Consensus Statement on Breast Cancer. Pathology and Oncology Research. 2022 Jun; 28: 1610373. doi: 10.3389/pore.2022.1610373.

[17] American College of Radiology. ACR Practice Parameter for the Performance of Ultrasound-Guided Percutaneous Breast Interventional Procedures. 2017.

[18] Gradishar WJ, Moran MS, Abraham J, Abramson V, Aft R, Agnese D *et al.* Breast Cancer, Version 3.2024, NCCN Clinical Practice Guidelines in Oncology. Journal of the National Comprehensive Cancer Network. 2024 Jul; 22(5): 331-57. doi: 10.6004/jnccn.2024.0035.

[19] Wang M, He X, Chang Y, Sun G, Thabane L. A Sensitivity and Specificity Comparison of Fine Needle Aspiration Cytology and Core Needle Biopsy in Evaluation of Suspicious Breast Lesions: A Systematic Review and Meta-Analysis. The Breast. 2017 Feb; 31: 157-66. doi: 10.1016/j.breast.2016.11.009.

[20] Javed MA, Aslam H, Hassan M, Murtaza M, Arshad M, Gillani MM. Diagnostic Accuracy of FNAC and Core Needle Biopsy in Palpable Breast Lumps: A Systematic Review and Meta-Analysis of Comparative Studies. Journal of Population Therapeutics and Clinical Pharmacology. 2025; 32(3): 238-251.

[21] Zaheer S, Shah N, Maqbool SA, Soomro NM. Estimates of Past and Future Time Trends in Age-Specific Breast Cancer Incidence among Women in Karachi, Pakistan: 2004-2025. BioMed Central Public Health. 2019 Jul; 19(1): 1001. doi: 10.1186/s12889-019-7330-z.

[22] Gadhia P, Joshi N, Vaniawala S. Assessment of the HER2 Equivocal Cases in Breast Cancer Following Laterality. Asian Pacific Journal of Cancer Biology. 2024 May; 9(2): 191-6. doi: 10.31557/apjcb.2024.9.2.191-196.

Copyright© 2026 The Authors. Published by CrossLinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0)