Accuracy of Mammography and Ultrasonography in Differentiating Benign and Malignant Breast Lesions Based on Histopathology at MRCCC Siloam Semanggi Hospital

Randi Eben Haezer[1], Nungky Kusumaningtyas[1], Mirna Muis[2], Denni Joko Purwanto[3], Nata Pratama Hardjo Lugito[4], Nina ISH Supit[1]

[1] Department of Radiology, Faculty of Medicine, Universitas Pelita Harapan, Jakarta, Indonesia
[2] Department of Radiology, Faculty of Medicine, Universitas Hassanudin, Makasar, Indonesia
[3] Department of Surgical Oncology, Dharmais Cancer Hospital – National Cancer Center, Jakarta, Indonesia
[4] Department of Internal Medicine, Faculty of Medicine, Universitas Pelita Harapan, Jakarta, Indonesia

Citation : Haezer, R. E., Kusumaningtyas, N., Muis, M., Purwanto, D. J., Lugito, N. P. H., & Supit, N. I. S. H. (2026). Accuracy of Mammography and Ultrasonography in Differentiating Benign and Malignant Breast Lesions Based on Histopathology at MRCCC Siloam Semanggi Hospital. Medicinus, 15(2), 7-15. https://doi.org/10.19166/med.v15i2.10725
Keywords: Mammography, Ultrasonography, Breast cancer, Diagnostic accuracy, ROC curve, Histopathology
Correspondance : Randi Eben Haezer
E-mail : randiebenhaezer1@gmail.com
Online First : 10 March 2026

Abstract

Background:
Breast cancer is the most common malignancy in women. Early detection improves survival. Mammography is the gold standard for women over 40, while ultrasonography is commonly used in younger women with dense breasts. To compare the diagnostic accuracy of mammography and ultrasonography in differentiating benign and malignant breast lesions using histopathology as the Gold standard.

Methods:
This cross-sectional analytic study included 91 patients who underwent mammography, ultrasonography, and histopathological confirmation at MRCCC Siloam Semanggi Hospital. Diagnostic parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, and area under the curve (AUC) were calculated. Statistical analysis used McNemar's test and ROC curve analysis based on Hanley & McNeil's method, with $p < 0.05$ considered significant.

Result:
Ultrasonography demonstrated higher sensitivity (98.4%) and NPV (92.3%) than mammography (96.7% and 88.9%), indicating better ability to rule out malignancy. Mammography showed higher specificity (53.3% vs. 40.0%) and PPV (80.8% vs. 76.9%), reflecting better performance in identifying benign lesions. Overall accuracy was slightly higher for mammography (82.4%) compared to USG (79.1%). The AUC for mammography was 0.750 (95% CI: 0.630–0.870), while USG had an AUC of 0.692 (95% CI: 0.565–0.819). Overlapping confidence intervals indicated no statistically significant difference in diagnostic accuracy between the two modalities ($p > 0.05$).

Conclusions:
Mammography and ultrasonography both demonstrated high diagnostic performance with complementary strengths. Mammography provided higher specificity and PPV, while USG offered superior sensitivity and NPV. Given the small difference in accuracy and overlapping AUC confidence intervals, no significant difference was found between the two modalities. Combined use of mammography and USG may improve diagnostic accuracy in clinical practice.

Introduction

Breast cancer is the most commonly diagnosed malignancy among women worldwide and remains the leading cause of cancer-related mortality. According to GLOBOCAN 2020 data, approximately 2.3 million new cases were reported globally, making breast cancer one of the highest incidence cancers and the fifth leading cause of cancer death.[1–3]

The high mortality rate is largely attributed to suboptimal early detection, despite evidence that timely screening and diagnosis improve patient survival. [4] Although breast self-examination (BSE) and clinical breast examination (CBE) raise awareness, they are no longer recommended as primary screening tools by the World Health Organization (WHO). In developing countries like Indonesia, mass mammography screening programs are challenging to implement due to high costs, limited medical personnel, and inadequate healthcare infrastructure, resulting in many cases being diagnosed at advanced stages.[5]

Diagnostic ultrasonography (USG) is the preferred imaging modality for women under 30 years and is considered equivalent to mammography for those aged 30 to 39. USG performs better in dense breast tissue and is more accessible but is highly operator-dependent and may yield higher false-negative rates when used for screening.[5,6]

Mammography remains the gold standard for screening women aged 40 and older but has limitations, including false positives, false negatives, overdiagnosis, and reduced sensitivity in dense breasts. Studies have shown that ultrasonography generally has higher sensitivity but lower specificity compared to mammography, and combining both modalities improves diagnostic accuracy.[6–10]

To date, no study at RS MRCCC Siloam Semanggi has compared the accuracy of mammography and USG in differentiating benign from malignant breast lesions based on histopathology. This study aims to analyze and compare the diagnostic accuracy of these two modalities to enhance early breast cancer detection in Indonesia.

Material And Methods

This study is a retrospective cross-sectional analytic study conducted at RS MRCCC Siloam Semanggi from January 2022 to December 2024. The study population comprised all patients with breast tumors who underwent mammography, ultrasonography (USG), and histopathological confirmation. Samples were consecutively selected from patient medical records that met the inclusion criteria, which required complete breast lesion data and histopathological confirmation. Exclusion criteria included patients with incomplete data, examinations performed outside RS MRCCC, and pregnant or lactating women. Mammography was performed using the Siemens Mammomat Inspiration device, while ultrasonography was conducted using the GE Logiq S8 system. Interpretation of mammography and USG results was performed by trained radiology residents and validated by two radiology specialists using the 2013 BI-RADS classification system, which categorizes lesions from category 1 (normal) to category 5 (highly suggestive of malignancy). Imaging data were correlated with histopathological findings classified as benign or malignant by anatomic pathologists.

Diagnostic parameters analyzed included sensitivity, specificity, positive and negative predictive values, accuracy, and area under the receiver operating characteristic curve (AUC). Comparative performance between the two modalities was assessed using McNemar's test for paired data and the Hanley-McNeil method for AUC difference analysis with a significance level of $p < 0.05$. Data were processed with the latest SPSS software following editing, coding, entry, and cleaning to ensure validity and consistency. This study was approved by the Ethics Committee of the Faculty of Medicine, Universitas Pelita Harapan (No. 247/K-LKJ/ETIK/VII/2025). All data were anonymized, and the study complied with the Declaration of Helsinki.

Result

This study included 91 patients with breast tumors at RS MRCCC Siloam Semanggi who underwent ultrasonography (USG) and mammography, followed by histopathological confirmation as the gold standard. Among the total sample, 61 cases (67.0%) were diagnosed as malignant tumors, while 30 cases (33.0%) were benign. Patient characteristics were described based on four major aspects. Firstly, age distribution showed that the majority of subjects were aged 40–50 years (41.7%), followed by those over 50 years (37.4%), and under 40 years (20.9%), reflecting a predominance of adult and elderly patients in this study population. Secondly, mammographic breast composition was predominantly type C (heterogeneously dense breast tissue) at 71.4%, followed by type D (extremely dense) at 14.3%, type B at 9.9%, and type A (almost entirely fatty) at 4.4%. This indicates a large proportion of patients with high breast density, which can potentially affect detection sensitivity (Table 1).

Table 1. Age Distribution and Breast Tissue Composition on Mammography.

Age (years)	Frequency	Percentage
< 40	19	20,9 %
40–50	38	41,7 %
> 50	34	37,4 %
Total	**91**	**100%**

Breast Composition	Frequency	Percentage
A	4	4,4 %
B	9	9,9 %
C	65	71,4 %
D	13	14,3 %
Total	**91**	**100%**

The distribution of BI-RADS categories on mammography revealed that categories 4 and 5, which are highly suggestive of malignancy, predominated at 36.3% and 43.9%, respectively. Only 19.8% of patients fell into categories 1–3, indicative of benign or non-suspicious findings. Similarly, ultrasonography showed predominance of BI-RADS categories 4 and 5, comprising 35.2% and 50.5% of cases, respectively, with no cases classified as category 1 and small proportions in categories 2 (7.7%) and 3 (6.6%). These data reflect a tendency for detection of suspicious lesions by both modalities, demonstrating consistency in interpretation between mammography and ultrasonography in identifying malignancy risk characteristics in breast tumors (Table 2)

Table 2. Distribution of Ultrasonography BI-RADS Classification on Mammography and Ultrasonography.

BIRADS on Mammography	Frequency	Percentage
1	3	3,3 %
2	8	8,8 %
3	7	7,7 %
4	33	36,3 %
5	40	43,9 %
Total	**91**	**100%**

BIRADS on Ultrasonography	Frequency	Percentage
1	0	0 %
2	7	7,7 %
3	6	6,6 %
4	32	35,2 %
5	46	50,5 %
Total	**91**	**100%**

The radiologic interpretation results revealed a relatively high detection rate for malignant lesions using both imaging modalities. Ultrasonography (USG) interpreted 78 cases (85.7%) as malignant and 13 cases (14.3%) as benign. Mammography (MG) showed 73 cases (80.2%) interpreted as malignant and 18 cases (19.8%) as benign. These data indicate a slightly higher tendency for malignancy interpretation with USG compared to mammography within this study population (Table 3).

Table 3. Distribution of Radiological Interpretation Results Based on Imaging Modalities.

Modality	Malignant Histopathology	Benign Histopathology	Total
USG	78 (85,7%)	13 (14,3%)	91
MG	73 (80,2%)	18 (19,8%)	91

The contingency comparison between ultrasonography (USG) and mammography (MG) results against histopathology illustrates the diagnostic performance of both modalities in differentiating malignant and benign breast tumors. For USG, among 61 histopathologically confirmed malignant cases, 60 (65.9%) were detected as true positives and only 1 (1.1%) as false negative. Eighteen cases (19.8%) were false positives, while 12 cases (13.2%) were true negatives from the total 30 benign cases. The overall positive and negative accuracy of USG reached 85.7% and 14.3%, respectively. In mammography, among 61 breast cancer cases (PA malignant), 59 were true positives (64.8%) and 2 false negatives (2.2%), while among 30 benign cases, 14 were classified as false positives (15.4%) and 16 as true negatives (17.6%). The total cases detected as malignant by mammography numbered 73 (80.2%), whereas 18 (19.8%) were categorized as benign (Table 4).

Table 4. Comparison USG and Mammography toward Histopathology.

Modality	Malignant Histopathology	%	Benign Histopathology	%	Total	%
USG (Malignant)	60 (TP)	65,9%	18 (FP)	19,8%	78	85,7%
USG (Benign)	1 (FN)	1,1%	12 (TN)	13,2%	13	14,3%
Total	**61**	**67,0%**	**30**	**23,0%**	**91**	**100%**

Modality	Malignant Histopathology	%	Benign Histopathology	%	Total	%
MG (Malignant)	59 (TP)	64,8%	14 (FP)	15,4%	73	80,2%
MG (Benign)	2 (FN)	2,2%	16 (TN)	17,6%	18	18,2%
Total	**78**	**67,0%**	**32**	**33,0%**	**91**	**100%**

The ROC curve analysis demonstrated the diagnostic performance of ultrasonography (USG) and mammography in differentiating between benign and malignant breast lesions. The area under the curve (AUC) for USG was 0.692 (95% CI: 0.565–0.819), while mammography had an AUC of 0.750 (95% CI: 0.630–0.870). The ROC curve depicted in Figure 1 indicates that mammography exhibited slightly superior diagnostic accuracy compared to USG, as reflected by its higher AUC, which suggests better discriminatory ability between benign and malignant lesions. This finding supports the use of mammography as the primary modality for early breast cancer detection in the studied population, without diminishing the important role of USG, particularly in cases involving dense breast tissue.

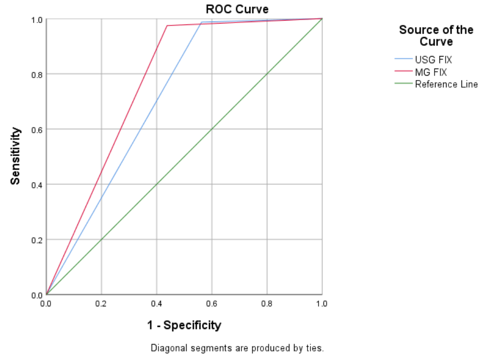

Figure 1. ROC Comparing USG and Mamography

The diagnostic parameter table comparing ultrasonography (USG) and mammography reveals differences in performance between the two modalities in detecting breast malignancies. USG demonstrated a very high sensitivity of 98.4%, slightly superior to mammography at 96.7%. However, USG showed a lower specificity of 40.0% compared to mammography's 53.3%, indicating a higher rate of false-positive findings with USG. Positive predictive value (PPV) was 76.9% for USG and 80.8% for mammography, while the negative predictive value (NPV) slightly favored USG at 92.3% versus 88.9%. Overall accuracy was relatively high for both, at 79.1% for USG and 82.4% for mammography. The receiver operating characteristic (ROC) curve analysis yielded area under the curve (AUC) values of 0.692 for USG and 0.750 for mammography, underscoring mammography's superior discriminatory ability between benign and malignant lesions in this study population (Table 5).

Table 5. Diagnostic Analysis on USG and Mammography.

Parameter	USG (%)	Mammography (%)
Sensitivity	98,4	96,7
Specificity	40,0	53,3
Positive Predictive Value (PPV)	76,9	80,8
Negative Predictive Value (NPV)	92,3	88,9
Accuracy	79,1	82,4
Area Under Curve (AUC)	0,692	0,750

The McNemar test analysis between mammography and ultrasonography (USG) in differentiating benign and malignant lesions shows in-depth results regarding the accuracy of the two modalities. In the contingency results, there were 13 cases assessed as benign by both modalities, while 73 cases were consistently identified as malignant by both mammography and USG. A total of 5 cases were assessed as malignant by USG but benign by mammography, and no cases were found where mammography assessed a lesion as benign while USG assessed it as malignant.

The p-value from the McNemar test was 0.063 ($p > 0.05$), indicating that there is no statistically significant difference in accuracy between mammography and ultrasonography (USG) in differentiating benign and malignant lesions in the study population.

Table 6. Comparison Mammography with Ultrasonography.

Modality	MG (Benign)	MG (Malignant)	Total
USG (Malignant)	13	0	13
USG (Benign)	5	73	78
Total	**18**	**73**	**91**

Discussion

This study directly compared the accuracy, sensitivity, specificity, and diagnostic value of two primary imaging modalities within a cohort at RS MRCCC Siloam Semanggi. The main findings demonstrated that ultrasonography (USG) exhibited a very high sensitivity of 98.4%, slightly surpassing mammography's 96.7%, consistent with literature reporting superior USG sensitivity in several Asian populations. For instance, Wang et al. (2022) and Tadesse et al. (2023) reported USG sensitivities of 95.7% and 94% per lesion, respectively, while mammography sensitivities were lower at 78.9% and 76% in their respective studies.[9,11]

The high sensitivity observed for both modalities in this study is influenced by the large proportion of patients with histopathologically confirmed malignant lesions (67.0%), thereby reducing the likelihood of false-negative results. This is critical for screening and early detection, as modalities with poor sensitivity risk missing cancer cases and delaying treatment. On the other hand, mammography exhibited better specificity (53.3%) compared to USG (40.0%), reflecting its superior accuracy in correctly identifying benign cases and reducing false-positive outcomes. When compared to Pereira et al. (2020), who reported very low USG specificity (18.8%), and Wang et al. (2022), who noted higher specificity (42.9%), this study underscores the advantage of mammography in detecting non-mass lesions such as microcalcifications.[12]

The cumulative overall accuracy data demonstrated that mammography (82.4%) slightly outperformed ultrasonography (USG) (79.1%), consistent with the respective receiver operating characteristic (ROC) curve area under the curve (AUC) values of 0.750 and 0.692. The higher AUC for mammography indicates a more optimal discriminative ability in distinguishing benign from malignant lesions, although the difference was relatively small with overlapping confidence intervals. In contrast, Wang et al. (2022) reported a higher AUC for USG in their population, while Tadesse et al. (2023) highlighted the strength of per-lesion analysis favoring USG, though per-patient results showed no significant difference.[11]

From a predictive standpoint, ultrasonography (USG) demonstrated a higher negative predictive value (NPV) of 92.3% compared to mammography's 88.9%, making it highly useful for confidently ruling out malignancy and avoiding unnecessary additional procedures. The positive predictive value (PPV) favored mammography at 80.8% over USG's 76.9%, providing greater certainty for positive cases. McNemar's test yielded a p-value of 0.063, indicating no statistically significant difference in accuracy between mammography and USG in differentiating benign and malignant lesions.

The BI-RADS distribution for both modalities supported these findings, with most cases classified as categories 4–5, representing a high suspicion of malignancy. Mammography categorized 80.2% of cases within BI-RADS 4–5, consistent with its strength in detecting microcalcifications and architectural distortions; however, its limitations in dense breasts were reflected by 19.8% of cases in categories 1–3. USG showed an even higher proportion of cases in categories 4–5 (85.7%), highlighting its proficiency in evaluating solid masses and lesion margins, especially in dense breast tissue. This pattern underscores the complementary nature of both imaging techniques, and their combined use can enhance diagnostic accuracy.

The accuracy difference between mammography and USG in this study was relatively small (approximately 3.3%), with overlapping confidence intervals for the AUC, indicating no significant difference based on statistical testing.

Several key factors influenced breast imaging diagnostic outcomes in this study. Firstly, breast density posed a significant challenge, with over 85% of patients classified as having dense breasts (BI-RADS categories C and D), consistent with characteristics of Asian and Indonesian female populations. High density reduces mammographic sensitivity due to fibroglandular tissue obscuring lesions, lowering diagnostic accuracy. Conversely, USG overcomes this limitation and remains reliable for lesion detection in dense breasts, as supported by Wang et al. (2022), who affirmed that breast density does not adversely impact USG performance and is a principal reason for its application in populations with dense breast tissue.[9]

Secondly, Age is a critical factor influencing the choice of imaging modality for breast cancer screening. Mammography is ideally recommended for women aged over 40 years, as breast tissue density typically decreases with age, enhancing the sensitivity of this technique for early cancer detection. Conversely, ultrasonography (USG) is preferred for women under 40, including pregnant patients, due to its lack of ionizing radiation and effectiveness in dense breast tissue. This preference is supported by Ilirian et al. (2023), who found mammography to be most sensitive in older age groups, whereas USG demonstrated higher accuracy among younger patients. Given that the majority of participants in this study were over 40 years of age, mammography remains relevant as the primary screening tool.[13] Third, operator dependency constitutes a significant inherent limitation of ultrasonography (USG). The accuracy of USG results is highly influenced by the skill and experience of the radiologist or sonographer, leading to considerable variation in interpretation between different operators or institutions. Such variability increases heterogeneity in outcomes and underscores the need for standardized examination protocols and intensive training of healthcare professionals to maintain consistent USG quality. Additionally, the detection of microcalcifications remains an exclusive advantage of mammography. Microcalcifications often represent an early manifestation of ductal carcinoma in situ (DCIS) and are critical for the early diagnosis of subclinical breast cancer. Ultrasonography is inadequate in optimally detecting microcalcification characteristics, thereby necessitating the integration of mammography into diagnostic workflows when non-mass lesions or architectural distortions without a distinct mass are suspected.[10,14]

The combination of these two imaging modalities has been well established in international literature. Chen et al. (2021) and several meta-analyses have demonstrated that using mammography and ultrasonography (USG) together increases sensitivity for breast cancer screening and diagnosis, especially for small lesions, populations with dense breasts, or clinically challenging diagnostic cases. [8,11]

This study has several limitations that should be considered when interpreting the findings. First, the limited sample size may render effect estimates more susceptible to the characteristics of the specific subjects studied. Second, since the study was conducted at a dedicated cancer referral hospital, the results may not fully represent the general population, warranting caution when generalizing these findings. Third, the operator-dependent nature of ultrasonography, combined with the retrospective design, means that image acquisition quality and interpretation may vary based on operator skill and the protocols used.

Conclusion

The study concluded that both ultrasonography (USG) and mammography exhibit high diagnostic accuracy in differentiating benign and malignant breast lesions, each with complementary characteristics. USG demonstrated superior sensitivity (98.4%) and negative predictive value (92.3%), making it highly effective for detecting malignant lesions, though its specificity was relatively low (40%), implying a higher false-positive rate. Conversely, mammography offered higher specificity (53.3%) and better positive predictive value, with an overall greater accuracy of 82.4%. Mammography remains superior in detecting microcalcifications and demonstrates higher specificity, making it the primary modality for screening women aged ≥40 years. Conversely, ultrasonography shows higher sensitivity and negative predictive value, particularly in dense breasts and younger patients (<40 years). The combined use of both modalities provides the most optimal outcome, as they complement each other in detecting and characterizing breast lesions, thereby enhancing diagnostic accuracy and improving clinical management efficiency.

Acknowledgment

None.

References

1. Ng B, Puspitaningtyas H, Wiranata JA, et al. Breast cancer incidence in Yogyakarta, Indonesia from 2008–2019: A cross-sectional study using trend analysis and geographical information system. *PLoS One*; 18. Epub ahead of print July 1, 2023. DOI: 10.1371/journal.pone.0288073.

2. Łukasiewicz S, Czeczelewski M, Forma A, et al. Breast cancer—epidemiology, risk factors, classification, prognostic markers, and current treatment strategies—An updated review. *Cancers*; 13. Epub ahead of print September 1, 2021. DOI: 10.3390/cancers13174287.

3. Smolarz B, Zadrożna Nowak A, Romanowicz H. Breast Cancer—Epidemiology, Classification, Pathogenesis and Treatment (Review of Literature). *Cancers*; 14. Epub ahead of print May 1, 2022. DOI: 10.3390/cancers14102569.

4. Obeagu EI, Obeagu GU. Breast cancer: A review of risk factors and diagnosis. *Medicine (United States)* 2024; 103: E36905.

5. Ginsburg O, Yip CH, Brooks A, et al. Breast Cancer Early Detection: A Phased Approach to Implementation. *Cancer* 2020; 126: 2379–2393.

6. Alotaibi BS, Alghamdi R, Aljaman S, et al. The Accuracy of Breast Cancer Diagnostic Tools.*Cureus*. Epub ahead of print January 7, 2024. DOI: 10.7759/cureus.51776.

7. Tari DU, Pinto F. Mammography in Breast Disease Screening and Diagnosis. *Journal of Personalized Medicine*; 13. Epub ahead of print February 1, 2023. DOI: 10.3390/jpm13020228.

8. Chen HL, Zhou JQ, Chen Q, et al. Comparison of the sensitivity of mammography, ultrasound, magnetic resonance imaging and combinations of these imaging modalities for the detection of small (≤2 cm) breast cancer. *Medicine (United States)* 2021; 100: E26531.

9. Wang Y, Li Y, Song Y, et al. Comparison of ultrasound and mammography for early diagnosis of breast cancer among Chinese women with suspected breast lesions: A prospective trial. *Thorac Cancer* 2022; 13: 3145–3151.

10. Nasional P, Kanker P. *KEMENTERIAN KESEHATAN REPUBLIK INDONESIA*.

11. Tadesse GF, Tegaw EM, Abdisa EK. Diagnostic performance of mammography and ultrasound in breast cancer: a systematic review and meta-analysis. *Journal of Ultrasound* 2023; 26: 355– 367.

12. Pereira R de O, da Luz LA, Chagas DC, et al. Evaluation of the accuracy of mammography, ultrasound and magnetic resonance imaging in suspect breast lesions. *Clinics* 2020; 75: 1–4.

13. Laçi I, Bërdica L, Nina H, et al. The diagnostic value of ultrasound and mammography in detection of breast cancer in Albania. *Int J Publ Health Sci* 2023; 12: 427–436.

14. Hossain MS, Ferdous S, Karim-Kos HE. Breast cancer in South Asia: A Bangladeshi perspective. *Cancer Epidemiology* 2014; 38: 465–470.

Author's Statement

The authors declared that all the images and figures in this manuscript is/are author's own work and/or has obtained necessary permission to re-use the content from the authors and publisher of respective materials.

(Randi Eben Haezer)