Al-Rafidain J Med Sci. 2026;11(1):87-94.
DOI: https://doi.org/10.54133/ajms.v11i1.3010

AJMS

Online ISSN (3219-2789)

Research Article

Kaiser Score in Multiparametric Breast MRI: Prospective Validation and Comparison with BI-RADS for Predicting Malignancy

Najah Raham Rashid*, Yusur Muhammad Said Al-Rawi, Yasameen Falah Aaber
Department of General Surgery, College of Medicine, Ibn Sina University of Medical and Pharmaceutical Sciences, Baghdad, Iraq
Received: 13 April 2026; Revised: 12 June 2026; Accepted: 16 June 2026

Abstract

Background: Early detection is essential to determine breast cancer prognosis. The reliability of BI-RADS diagnoses varies, and the level of agreement between radiologists who read the same test is moderate at best. Kaiser Score offers a framework for evaluating breast lesions. ***Objective***: To evaluate the breast cancer diagnostic landscape in Iraq by analyzing the Kaiser Score compared to the combination with BI-RADS. ***Methods***: A prospective, cross-sectional diagnostic accuracy study was conducted at Private Radiology Center in Baghdad during December 2023 to December 2025. The study comprised 52 female patients, with a total of 90 suspected breast lesions, who needed multiparametric MRI to assess a recent abnormality found through ultrasonography or mammography, or to diagnose breast complaints with available Kaiser Score parameters and underwent histopathological examination for confirmation of diagnosis. ***Results***: Kaiser score was significantly higher in malignant than in benign lesions (8.62 *vs*. 3.23, $p<0.001$). Regarding BI-RADS, the highest proportion of malignant lesions was seen significantly among lesions classified as BI-RADS 5 (95%, $p<0.001$). A Kaiser score >6 is a predictor for malignant breast lesions. It was 94.3% sensitive, 98.2% specific, and 96.7% accurate. Sensitivity for lesions with a score of 4 or 5 BI-RADS was 97.1%, specificity was 67.3%, and accuracy was 78.9%. ***Conclusions***: With KS, we can achieve better overall accuracy and more specificity. On its own, BI-RADS is quite sensitive, but it lacks specificity. Implementing a combination of the two could lead to better decisions and fewer needless biopsies.

Keywords: Breast malignancy; BI-RADS; Kaiser score; Lesion; MRI.

تقييم كايزر في تصوير الثدي بالرنين المغناطيسي متعدد المعايير: التحقق المستقبلي والمقارنة مع BI-RADS للتنبؤ بالورم الخبيث

الخلاصة

الخلفية: الكشف المبكر ضروري لتحديد التشخيص بسرطان الثدي. تختلف موثوقية تشخيصات BI-RADS، ومستوى الاتفاق بين أطباء الأشعة الذين قرأوا نفس الاختبار متوسط في أفضل الأحوال. يقدم كايزر سكور إطارا لتقييم آفات الثدي. **الهدف**: تقييم مشهد تشخيص سرطان الثدي في العراق من خلال تحليل تقييم كايزر مقارنة بالجمع مع BI-RADS. **الطرائق**: أجريت دراسة استقبالية لدقة التشخيص المقطعي في مركز الأشعة الخاص في بغداد خلال الفترة من ديسمبر 2023 إلى ديسمبر 2025. شملت الدراسة 52 مريضة، مع إجمالي 90 مشكلة مشتبه بها في إصابة الثدي، واحتجن إلى تصوير بالرنين المغناطيسي متعدد المعايير لتقييم شذوذ حديث تم اكتشافه عبر الموجات فوق الصوتية أو التصوير الشعاعي للثدي، أو لتشخيص مشاكل الثدي باستخدام معايير كايزر Score المتاحة، وخضعوا لفحص نسيجي مرضي لتأكيد التشخيص. **النتائج**: كانت درجة كايزر أعلى بشكل ملحوظ في الآفات الخبيثة مقارنة بالآفات الحميدة (8.62 مقابل 3.23، ص<0.001). فيما يتعلق ب BI-RADS، لوحظت أعلى نسبة من الآفات الخبيثة بشكل ملحوظ بين الآفات المصنفة كابا-رادز 5 (95٪، ص<0.001). درجة كايزر >6 هي مؤشر على آفات الثدي الخبيثة. كان التقييم حساسا بنسبة 94.3٪، و98.2٪ محدد، ودقة بنسبة 96.7٪. كانت الحساسية للآفات التي حصلت على درجة 4 أو 5 في BI-RADS 97.1٪، وخصوصية 67.3٪، والدقة 78.9٪. **الاستنتاجات**: مع KS، يمكننا الحصول على دقة عامة أفضل ومزيد من الدقة. BIRADS بمفرده، حساس جدا، لكنه يفتقر إلى التحديد. تطبيق الجمع بين الاثنين قد يؤدي إلى قرارات أفضل وتقليل الخزعات غير الضرورية.

* ***Corresponding author***: Najah R. Rashid, Department of General Surgery, College of Medicine, Ibn Sina University of Medical and Pharmaceutical Sciences, *Baghdad, Iraq*; Email: sigitadiprasetyo2024@gmail.com
Article citation: Rashid NR, Al-Rawi YMS, Aaber YF. Kaiser Score in Multiparametric Breast MRI: Prospective Validation and Comparison with BI-RADS for Predicting Malignancy. *Al-Rafidain J Med Sci.* 2026;11(1):87-94. doi: https://doi.org/10.54133/ajms.v11i1.3010

INTRODUCTION

Among females, breast cancer accounts for most cancer-related deaths. In 2020, less developed regions of the world accounted for over half of the breast cancer diagnoses and two-thirds of the breast cancer deaths, despite the disease's former dominance in industrialized countries [1]. Worldwide, 2.3 million women were diagnosed with breast cancer in 2022, with 670,000 losing their lives to the disease. It strikes women worldwide and at any age after puberty, though the rates seem to increase as the women get older [2]. Early detection is the single most essential factor in determining breast cancer prognosis. Improving the prognosis of a disease is possible with prompt diagnosis [3,4]. Research shows that patients whose diagnoses are made earlier tend to have better survival rates compared to those whose diagnoses are made later [5]. In low- and middle-income countries (LMICs), breast cancer is more commonly diagnosed at a later stage. Breast cancer patients in High-Income Countries (HIC) are more likely to be in stages I-II, according to the available information, but in Low- and Middle-Income

Countries (LMIC), less than half of the patients diagnosed are in early stages [6]. Early identification alleviates patients' financial and emotional burdens by minimizing the need for expensive therapies such as radiation and chemotherapy [7]. With 94% to 100% sensitivity for detecting breast malignancy, higher than ultrasound and mammography, magnetic resonance imaging (MRI) is an essential imaging modality for screening breast malignancy in individuals with a high familial or hereditary risk of developing the disease [8]. Despite its strengths, breast MRI faces challenges, including high false-positive rates (leading to unnecessary biopsies), lower specificity for lesion characterization due to the overlap in morphology and kinetics between benign and malignant lesions on MRI, high cost, patient discomfort (claustrophobia), and restricted use for patients with metal implants [9]. For evaluating breast lesions, the BI-RADS lexicon is commonly used. The reliability of BI-RADS diagnoses varies, and the level of agreement between radiologists who read the same test is moderate at best [10]. Without a clear guideline, the evaluation can be difficult because it depends on the evaluator's experience, which could result in various choices [11]. In this regard, Werner Alois Kaiser's (KS) four-part diagnostic framework for breast lesion evaluation considers characteristics of the lesion's border, the type of kinetic enhancement curve, the presence of edema, and internal enhancement [12]. As a clinical decision rule for assessing the chance of malignancy, a system of scoring is applied through a flowchart with a three-step tree [13]. Improving diagnosis accuracy and inter-reader agreement, particularly for less experienced radiologists, has been achieved by using the KS to breast MRI interpretation. The KS can lessen diagnostic uncertainty by methodically assessing lesions using a standardized scoring system [14]. The aim of this study is to assess the diagnostic performance of KS in predicting malignancy in breast lesions detected on multiparametric MRI and to compare its predictive performance against BI-RADS for breast cancer malignancy.

Key message

Many women in Iraq are still diagnosed at a relatively advanced stage. Despite the growing utilization of multiparametric breast MRI in Iraq for preoperative assessment and problem-solving, MRI interpretation is still subjective and might vary among institutions and radiologists. The KS aims to standardize MRI assessment and enhance the prediction of malignancy using a structured, evidence-based decision process. Despite encouraging results on a global scale, its diagnostic efficacy in Iraqi patients or with local imaging modalities is still unknown. Therefore, it is crucial to validate the KS in Iraq to find out if it may effectively help with cancer risk stratification, decrease variability among observers, and maximize the use of our limited healthcare resources for biopsy and follow-up decisions. Limited resources and differences in diagnostic procedures are just two of the many obstacles faced by Iraqi healthcare institutions. This study aims to evaluate the breast cancer diagnostic landscape in Iraq by analyzing the KS in comparison and in combination with BI-RADS. More successful patient outcomes may result from enhanced clinical pathways and radiology training made possible by the results.

METHODS

Study design and setting

This prospective, cross-sectional diagnostic accuracy study was conducted at a private radiology center in Baghdad during a period of two years from December 2023 to December 2025.

Study patients and inclusion criteria

The study comprised, initially, 78 female patients, whom they assessed for eligibility. The final total number included in this study was 52 female patients with 90 breast lesions (26 females were excluded) who were aged above 18 years and who presented to the Radiology Center with suspected breast lesions and needed multiparametric MRI to assess a recent abnormality found through ultrasonography or mammography, or to diagnose breast complaints, with available KS parameters and underwent histopathological examination for confirmation of diagnosis.

Exclusion criteria

Females with contraindications to MRI (11 patients), with prior breast surgery (eight patients), or with treatment that could bias the results, those with incomplete data (Five patients), or those who refused to participate in this study (Two patients) were excluded.

Sample size calculation

For the minimal sample size required to attain appropriate statistical power in order to compare the diagnostic accuracy of BI-RADS and KS in predicting the malignancy of breast cancer, we used the following formula [15, 16]:

$$n=(Z\alpha/2+Z\beta)^2 * (p1(1-p1) + p2(1-p2))/(p1-p2)^2$$

Where $Z\alpha/2 = 1.96$ for $\alpha = 0.05$, $Z\beta = 0.84$ for 80% power, p1 = Expected sensitivity or proportion for BI-RADS (70.1%) [17], and p2 = Expected sensitivity or proportion for Kaiser Score (95%) [18]. Thus, for a study comparing the sensitivities of the Kaiser Score and BI-RADS with the given proportions, we need 33 lesions in each one, so 66 lesions are the required sample. The final sample size was revised to 90 lesions to account for a 20% non-response rate and to enhance the study's power.

Data collection and MRI procedure

Certain information was collected, such as age, clinical variables (number, side, site, shape, and margin of lesion), and medical history (hypertension, DM, coronary heart disease, prior stroke, and smoking). A 1.5T Philips Achieva imager (Philips Medical Systems, Best, The Netherlands) was used to obtain MR images. A bilateral phased-array 7-channel breast coil was applied before imaging. Examination of patients was done in the prone position; MR investigation was carried out in the 2nd week of the menstrual cycle for women who were of childbearing age. A gadolinium-based contrast agent (gadobutrol 1.0 mmol/mL) was administered intravenously at a dose of 0.1 mmol/kg body weight at a rate of 2 mL/s followed by a 20-mL saline flush. The imaging protocol included axial T1-weighted (TR/TE: 350/15, bandwidth: 45.25 Hz/pixel; field of view [FOV]: 32 mm; slice thickness: 4.0 mm; matrix size: 384 × 256; number of excitations [NEX]: 1.5), axial short tau inversion recovery (STIR) (TR/TE: 3500/50; bandwidth: 70.50; FOV: 32 mm; slice thickness: 4.0 mm; matrix size: 320 × 256; NEX: 1.5), and axial T2 weighted (TR/TE: 5000/80; bandwidth: 40.25; FOV: 32; slice thickness: 4.0 mm with no intersection gap; matrix size: 352 × 288; NEX: 1.5; flip angle: 70). Spectral attenuated inversion recovery (SPAIR), TE/TR (5000/400), FA: 60, bandwidth: 350 Hz, and diffusion-weighted imaging (DWI), TR/TE (50/15), FA: 40, bandwidth: 40 Hz. T1W dynamic fat sat with 7 dynamic scans. TR/TE (850/40), bandwidth: 400 Hz

Image analysis

As illustrated in Figure 1, specialized breast radiologists analyzed all breast MRIs. The image analysis was conducted prospectively, and none of the patients had prior histopathological results.

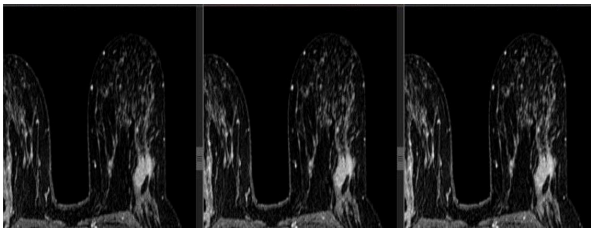

Figure 1: Irregular shape partly spiculated outline mass lesion in the left breast 3 o'clock showing heterogeneous enhancement consistent with malignant BIRADS 5 lesions.

Our imaging interpretation adhered to the American College of Radiology BI-RADS-MRI vocabulary, edition 5. Lesions classified as BI-RADS category 4 underwent further analysis based on morphologic features and dynamic enhancement profile. Any increasing space-occupying lesion with a diameter greater than 5 mm was classified as a mass lesion (ML). A non-mass lesion (NML) is an improved area that does not have 3D mass or conventional mass features. The evaluation of the dynamic enhancement profile revealed either a quick washout, a plateau, or patterns that persisted over time. Any lesion's most worrisome curve pattern that showed an enhancement of more than 2% was taken into account for interpretation. We found that ML patients had irregular or microlobulated shapes; poorly defined or spiculated borders; uneven, ring-enhanced, or continuous distribution of contrast media; and significant, fast, plateau, or continuous washout contrast enhancement both at the beginning and end of the imaging process. A localized, linear, ductal, segmental, or heterogeneous regional pattern of enhancement was concentrated in patients with NML.

BI-RADS classification

A standard numbering system that is used in this study to categorize the imaging results and report the risk of cancer. Every imaging lesion (mass, nodule, observation, etc.) was given a BI-RADS number. It assigns results to one of six categories [19]: BI-RADS-1: Negative results; no cancer; BI-RADS-2: Negative results; non-cancerous findings such as cysts or fibroadenoma; 0% cancer risk. Continue routine screening, BI-RADS-3: Probably negative results; nevertheless, a 2% possibility of cancer exists; the physician may advise a further scan in six months to verify the absence of malignant intent. BI-RADS-4: Positive results; a mass or anomaly warrants further investigation; a biopsy is advised (4A: Low likelihood (from 2% to 10%) of cancerous results, 4B: Moderate likelihood (from 10% to 50%) of cancerous results, 4C: High likelihood (from 50% to 95%) of cancerous results, and BI-RADS-5: Positive results; it is strongly advised to have a biopsy to confirm the presence of breast cancer, as the likelihood of its presence is 95%, and BI-RADS-6: Images marked with this category reveal the cancer's response to treatment; they are reserved for patients who have previously undergone a biopsy to confirm a breast cancer diagnosis.

Kaiser score

It offers a standardized flowchart with eleven outcome classes and five diagnostic criteria taken from the BI-RADS. The system evaluates five main MRI characteristics: Root sign: Presence of spiculated margins (radiating lines from the lesion); time–signal intensity curve, type 1 (persistent) → usually benign, type 2 (plateau) → intermediate suspicion, and type 3 (washout) → highly suggestive of malignancy; margins, circumscribed (smooth) → benign tendency and irregular or spiculated → suspicious; internal enhancement pattern, homogeneous → more likely benign, heterogeneous or rim enhancement → more suspicious, and rim enhancement is particularly associated with malignancy; and peritumoral edema, presence of edema around the lesion increases suspicion. The score ranged from 1 to 11, which directly translates to a BI-RADS category for management recommendations; low risk of breast cancer is indicated

by a score of 1-4, an intermediate risk by 5-7, and a high risk by 8-11 [13].

Workup

Before the analysis of MRI images, a training session was held. For each lesion, BI-RADS and KS were assigned by two radiologists. A re-discussion was made for the cases that showed disagreement between them, and then after reaching a consensus, the final score was determined. During the image analysis phase, the radiologists were not informed of the histological results.

Ethical considerations

The Declaration of Helsinki lays forth the ground rules for ethical conduct. Approval was obtained from the Ibn Sina University of Medical and Pharmaceutical Sciences Ethics Committee. Written informed consent was acquired from all patients or surrogates. Data were stored securely using coded identifiers in a password-protected environment.

Statistical analysis

Statistical Package for the Social Sciences (SPSS) version 28 was used to analyze the data. Mean, standard deviation, and range are the data presented. Statistics show as percentages and frequencies for categories. To compare the continuous variables, an independent t-test with two tails was employed. The connection between provisional diagnosis and BI-RADS classification was assessed using a chi-square test. When the expected frequency was less than 5, the Fisher exact test was employed instead. Using binary logistic regression analysis, we were able to identify independent predictors of malignant lesions. So, margin, internal enhancement, curve type, spiculation, and edema were entered, and a backward stepwise method was applied (due to low cell counts, spiculated margins were included in the non-circumscribed margins category). Inter-rater agreement for qualitative (categorical) items was measured by Cohen's Kappa Coefficient (κ). For predicting KS levels as diagnostics of malignant breast lesions, receiver operating characteristic (ROC) curve analysis was employed. For statistical significance, a *p*-value of less than 0.05 was used.

RESULTS

Patients' characteristics are presented in Table 1. The age ranged from 23 to 59 years (mean 43.81 ± 7.5 years); 71.2% of them were living in urban areas, 30.8% were current smokers, 25% were hypertensive, 36.5% had a family history of malignancy; 65.4% of lesions were unilaterally located, and 48.1% of cases had only one lesion. As shown in Table 2, 53.3% of lesions were irregular in shape; 47.8% of them were between 2 and 5 cm in size; 30% had circumscribed margins; 54.4% were heterogeneous in internal enhancement; the MRI enhancement curve was type 1 in 57.8%; spiculation (root sign) was presented in 53.3%; and 15.6% of lesions showed edema.

Table 1: Patients' characteristics (n=52)

Variable	n(%)
Age Groups (year)	
< 40	10(19.2)
≥ 40	42(80.8)
Residence	
Urban	37(71.2)
Rural	15(28.8)
Smoking status	
Current smoker	16(30.8)
Nonsmoker	36(69.2)
Medical history	
HTN	13(25)
DM	5(9.6)
Coronary artery disease	7(13.5)
No	34(65.4)
Family history of malignancy	
Yes	19(36.5)
No	33(63.5)
Lesion side	
Unilateral	34(65.4)
Bilateral	18(34.6)
Number of lesions	
One	25(48.1)
Two	18(34.6)
Three or more	9(17.3)

Table 2: Lesions' characteristics (n= 90)

Variable	n(%)
Shape	
Oval	35(38.9)
Round	7(7.7)
Irregular	48(53.3)
Size (cm)	
< 2	36(40)
2 - 5	43(47.8)
> 5	11(12.2)
Margin	
Circumscribed	27(30)
Non-circumscribed	23(25.6)
Irregular	18(20)
Spiculated	14(15.6)
Regular	8(8.8)
Internal Enhancement	
Heterogeneous	49(54.4)
Homogeneous	31(34.4)
Na	8(8.9)
Rim	3(3.3)
MRI Enhancement Curve	
Type 1	52(57.8)
Type 2	24(26.7)
Type 3	14(15.5)
Spiculation (Root sign)	
Yes	48(53.3)
No	42(46.7)
Edema	
Yes	14(15.6)
No	76(84.4)
Diagnosis (Histopathological Result)	
Breast Cancer	35(38.9)
Granulomatous mastitis	21(23.3)
Fibroadenoma	16(17.8)
Ductal hyperplasia	10 (11.1)
Cyst	8(8.9)

Regarding histopathological examination (provisional diagnosis), 38.9% of lesions were malignant. Logistic

regression analysis identified significant predictors of malignant lesions (Table 3). Margin, internal enhancement pattern, kind of enhancement curve, spiculation, and edema were the variables that were initially entered into the logistic regression model.

Table 3: Independent predictors of malignant lesions by logistic regression

Predictors of malignant lesions	Odds Ratio	95% CI	*p*-value
Margin (Reference: Circumscribed)			
Non-circumscribed	8.34	4.15-21.72	0.001
Irregular	4.81	1.92-13.2	0.016
Enhancement Curve (Reference: Type 1)			
Type 3	12.27	6.18-31.1	0.001

All variables that lost their statistical significance were removed using a backward stepwise (or enter) method. Three factors were found to be important independent risk factors for malignancy. Non-circumscribed margins are 8.34 more likely to be diagnosed as malignant lesions than circumscribed ones (OR= 8.34 with 95% CI: 4.15 to 21.72); irregular margins are 4.81 more likely to be malignant than circumscribed (OR= 4.81 with 95% CI: 1.92 – 13.2); and enhancement curves of type 3 are 12.27 more likely to be malignant lesions than those of type 1 (OR= 12.27 with 95% CI: 6.18 to 31.1). BI-RADS classification of lesions showed that 32 (35.6%) lesions were classified as BI-RADS 4 and 30 (33.3%) were classified as BI-RADS 3. According to KS, 47 (52.2%) of lesions were classified as low risk for malignancy and 28 (31.1%) were classified as high risk for malignancy (Figure 2).

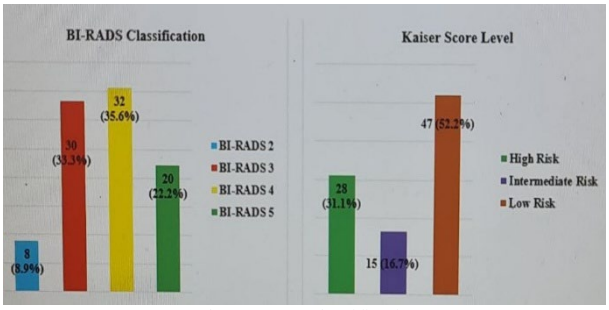

Figure 2: BI-RADS and KS scores classifications.

Table 4 showed the level of agreement between the two radiologists regarding lesion BI-RADS. Radiologist 1 and Radiologist 2 showed the same BI-RADS level in 86 lesions, while there was disagreement between them in four lesions. So, there was a statistically significant perfect agreement between the two radiologists (k= 0.909, $p< 0.001$).

Table 4: Agreement in Lesion BI-RADS between the two radiologists

BI-RADS (Radiologist 1)	BI-RADS (Radiologist 2)		Total (n=90)	*p*-value
	2 or 3	4 or 5		
2 or 3	36	2	38	
4 or 5	2	50	52	<0.001
Total	38	52	90	

Table 5 showed the level of agreement between the two radiologists regarding Lesion KS. Radiologist 1 and Radiologist 2 showed the same risk level in 81 lesions, while there was disagreement between them in nine lesions. So, there was a statistically significant very good agreement between the two radiologists, (k= 0.83, $p< 0.001$). The mean of KS was significantly higher in malignant than that in benign lesions (8.62 vs. 3.23, $p< 0.001$).

Table 5: Agreement in risk assessment by KS level between the two radiologists

Risk by KS (Radiologist 1)	Risk by KS (Radiologist 2)			Total	*p*-value
	High	Intermediate	Low		
High	26	2	0	28	<0.001
Intermediate	1	11	3	15	
Low	1	2	44	47	
Total	28	15	47	90	

Regarding BI-RADS, the highest proportion of malignant lesions was seen significantly among lesions classified as BI-RADS 5 (95%, $p< 0.001$), indicating a statistically significant association between BI-RADS classification and histopathological results of breast lesions as shown in Table 6.

Table 6: Association of BI-RADS and KS with histopathological results of breast lesions

Variable	Histopathological results		Total (n= 90)	*p*-value
	Malignant (n=35)	Benign (n= 55)		
KS	8.62±1.8	3.23±1.7	-	<0.001
BI-RADS				
2	0(0.0)	8(100)	8(8.9)	<0.001
3	1(3.3)	29(96.7)	30(33.3)	
4	15(46.9)	17(53.1)	32(35.6)	
5	19(95)	1(5.0)	20(22.2)	

Values are presented as frequency, percentage and mean±SD.

The sensitivity for lesions with a score of 4 or 5 BI-RADS score was 97.1%, while the specificity was 67.3%. Overall diagnostic accuracy is 78.9% (Table 7).

Table 7: Sensitivity, specificity, and accuracy of BI-RADS in predicting malignant breast lesions

BI-RADS Score	Histopathology		Total
	Malignant lesion	Benign lesion	
Positive (4 and 5)	34	18	52
Negative (2 and 3)	1	37	38
Total	35	55	90

ROC curve analysis was constructed for KS as a predictor for malignant breast lesions. As shown in Figure 3, the cut-off point of KS was 6. So, KS > 6 is a predictor for malignant breast lesions as a large significant area under the curve (AUC= 96.6%), indicating a significant association between a higher level of KS and the prediction of malignant breast lesions. KS was 94.3% sensitive, 98.2% specific, and 96.7% accurate.

DISCUSSION

There is an urgent need for better diagnostic methods to improve early diagnosis of breast cancer, since it is still

the top cancer killer of women globally [20]. Interpretation variability in breast MRI is a problem, according to previous research.

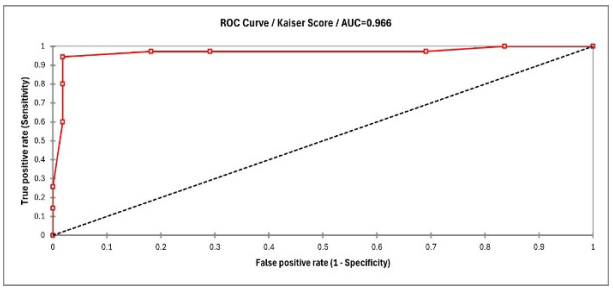

Figure 3: ROC curve which represents sensitivity, specificity and cut point of KS (Cut off point: 6; Sen. 94.3%; Spe. 98.2%; PPV 97.1%; NPV 96.4%; and acc. 96.7%).

This is especially true for intermediate BI-RADS categories. In response, KS lessens reliance on readers by offering a replicable, evidence-based decision process [21]. Our study confirmed that KS is a strong model for predicting breast lesion malignancy in multiparametric MRI scans. The AUC is 96.6%, which is rather impressive. This discovery emphasizes the strong relationship between KS and breast cancer histology, as well as its ability to improve clinical decision-making. However, patients may be anxious about undergoing unneeded biopsies due to the BI-RADS classification system's moderate specificity (67.3%). This is in contrast to the system's high sensitivity (97.1%). We can increase diagnostic accuracy and patient outcomes in breast cancer care by merging KS with BI-RADS assessments and utilizing the benefits of both systems. These findings are agreed with the results found by Chen *et al*. (2022) [22] and Mohammadzadeh *et al*. in their 2025 [23] studies, who concluded that with a far better specificity than BI-RADS, KS may reduce the need for needless biopsies; it also demonstrated good sensitivity in identifying malignant breast lesions, providing further evidence for its efficacy in clinical settings. The results demonstrate that integrating morphological and functional MRI features into a structured algorithm significantly improves lesion characterization. Meng *et al*., in 2022, reported that by integrating T1 into the KS protocol, the ability to distinguish between benign and malignant breast lesions was enhanced, perhaps leading to a reduction in the need for invasive operations that aren't necessary [24]. Woitek *et al*. found lower sensitivity and specificity of the KS for differentiating between benign and malignant lesions (80.6% and 82.5%, respectively) [25]. Milos *et al*. study showed that sensitivity of KS is between 92.7 and 97.6% [18], which is like our study. Further evidence that contrast-enhanced mammography warrants clinical development and deployment is the fact that KS performed using this method was more cost-effective than MRI in distinguishing between benign and malignant breast lesions [26].

Clinical Implications

The importance of this work appeared because it examines in depth a crucial area of oncology (diagnosis of breast cancer) by investigating sophisticated diagnostic approaches, which are becoming more important as the prevalence of breast malignancies rises around the world. This study offers important insights into how to enhance these tools for better clinical outcomes by analyzing the efficacy of the KS with the BI-RADS categorization system. Because it considers both structural and functional parameters of the lesions, multiparametric MRI is a huge step forward in improving diagnostic accuracy when included in the evaluation framework. In addition, the study stands out for its innovative focus on determining a distinct cut-off point for KS at 6, backed by an impressively high area under the curve (AUC= 96.6%). This solves a long-standing problem in breast imaging by quantifying the KS's function in reliably differentiating benign from cancerous spots. The results open the door to better clinical practice, which may lead to fewer needless biopsies due to the BI-RADS system's lower specificity.

Strengths and Limitations of the Study

This work adds to the existing body of information by shedding light on the synergy between these factors; it calls for a more comprehensive strategy to detect breast cancer, one that gives equal weight to sensitivity and specificity, with the goal of bettering patient care and management. Despite its value, this study has limitations, such as being single-center; the results may not be generalized to other settings. Results could be more broadly applicable, and clinical practice variability could be better captured by multi-center studies. Radiologists' levels of experience might introduce bias into the interpretation of multiparametric MRI findings, casting doubt on their validity; not all patients had a single lesion. The lack of systematic correction for intra-patient clustering in the lesion-based analyses may have caused the confidence intervals to be excessively narrow and the standard errors to be slightly underestimated. We do not anticipate this to alter the primary findings, either, because the impact sizes that were noted were substantial. Finally, despite the inclusion of DWI in our acquisition methodology, ADC values were not thoroughly examined in this work. It would be beneficial for future research to investigate if our population's diagnostic performance is further enhanced by incorporating ADC into the Kaiser Score.

Conclusion

According to the findings of this study, both KS and BI-RADS are useful tools for determining breast cancer risk. When compared to the BI-RADS system, which provides a very accurate cut-off point for cancer

diagnosis but is moderately specific and could result in needless biopsies, the KS provides a higher specific cut-off rate with overall diagnostic accuracy. By this strong predictive capability, the likelihood of incorrect diagnoses is reduced, leading to better clinical decision-making and better patient outcomes. However, clinicians would be able to make better judgments about additional examination and therapy if the two tests were integrated, which would increase diagnostic accuracy.

Recommendations

Oncologists and radiologists can participate in ongoing training sessions that cover the use and interpretation of KS. Its incorporation into routine practice can be facilitated by raising knowledge of its advantages. The efficacy of the KS across different populations and communities has to be further investigated. To further establish KS's relevance in clinical practice, future research should examine the long-term results of patients diagnosed using KS. Also, radiologists, pathologists, and oncologists can work together more effectively to improve the accuracy of cancer diagnoses. Decisions based on KS and imaging data can be aided by regular case discussions and multidisciplinary tumor boards.

ACKNOWLEDGMENTS

The authors thank to the technicians and nursing staff for their assistance in patient care and data collection. We are grateful for individuals' willingness to share their experiences and data.

Conflict of interests

The authors declared no conflict of interest.

Funding source

The authors did not receive any source of funds.

Data sharing statement

The data that supports the findings of this study are available from the corresponding author upon a reasonable request.

REFERENCES

1. Wilkinson L, Gathani T. Understanding breast cancer as a global health concern. *Br J Radiol*. 2022;95(1130):20211033. doi: 10.1259/bjr.20211033.
2. Freihat O, Sipos D, Kovacs A. Global burden and projections of breast cancer incidence and mortality to 2050: a comprehensive analysis of GLOBOCAN data. *Front Public Health*. 2025;13:1622954. doi: 10.3389/fpubh.2025.1622954.
3. Khan AQ, Touseeq M, Rehman S, Tahir M, Ashfaq M, Jaffar E, et al. Advances in breast cancer diagnosis: a comprehensive review of imaging, biosensors, and emerging wearable technologies. *Front Oncol*. 2025;15:2025. doi: 10.3389/fonc.2025.1587517.
4. Albahadili M, Ismael SM, Al-Samarraee MF. Is it possible to manage appendicular mass without surgery? *Al-Rafidain J Med Sci*. 2025;9(2):46-50. doi: 10.54133/ajms.v9i2.2322.
5. Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2022. *Cancer J Clinicians*. 2022;72(1):7-33. doi: 10.3322/caac.21708.
6. Pace LE, Uwihaye JdD, Mukandayisenga V, Fata AM, Rositch AF, Byiringiro J, et al. Early experience scaling up a breast cancer early detection initiative integrated with cervical cancer screening in Rwanda. *BMJ Glob Health*. 2025;10(10):e021235. doi: 10.1136/bmjgh-2025-021235.
7. Wilkerson AD, Gentle CK, Ortega C, Al-Hilli Z. Disparities in breast cancer care—How factors related to prevention, diagnosis, and treatment drive inequity. *Healthcare*. 2024;12(4):462. doi: 10.3390/healthcare12040462.
8. Washington I, Palm RF, White J, Rosenberg SA, Ataya D. The role of MRI in breast cancer and breast conservation therapy. *Cancers (Basel)*. 2024;16(11). doi: 10.3390/cancers16112122.
9. Giannakaki AG, Giannakaki MN, Baroutis D, Koura S, Papachatzopoulou E, Marinopoulos S, et al. Preoperative breast MRI and histopathology in breast cancer: Concordance, challenges and emerging role of CEM and mpMRI. *Diagnostics*. 2025;15(23):3032. doi: 10.3390/diagnostics15233032.
10. Ren T, Li X, Xiang Y, Zhang Y, Jiang M, Zhang C. The diagnostic significance of the BI-RADS classification combined with automated breast volume scanner and shear wave elastography for breast lesions. *J Ultrasound Med*. 2023;42(7):1459-1469. doi: 10.1002/jum.16154.
11. Baltzer PAT, Krug KB, Dietzel M, (Eds.), Evidence-based and structured diagnosis in breast MRI using the Kaiser Score. Georg Thieme Verlag KG. 2022;194(11):1216-1228. doi: 10.1055/a-1829-5985.
12. Erkan M, Ozcan SGG. Diagnostic performance of kaiser score for characterization of breast lesions on modified abbreviated breast MRI and comparison with full-protocol breast MRI. *J Clin Med*. 2025;14(1):264. doi: 10.3390/jcm14010264.
13. Dietzel M, Baltzer PA. How to use the Kaiser score as a clinical decision rule for diagnosis in multiparametric breast MRI: a pictorial essay. *Insights Imaging*. 2018;9(3):325-335. doi: 10.1007/s13244-018-0611-8.
14. Zhou XZ, Liu LH, He S, Yao HF, Chen LP, Deng C, et al. Diagnostic value of Kaiser score combined with breast vascular assessment from breast MRI for the characterization of breast lesions. *Front Oncol*. 2023;13:1165405. doi: 10.3389/fonc.2023.1165405.
15. Li J, Knigge R, Chen K, Leary EV. PASSED: calculate power and sample size for two sample tests. *RJ*. 2021;13(2): 542-560. doi: 10.32614/RJ-2021-094.
16. Al-Samarraee MF, Kadhim ST, Al-Atta DM, Fadhil AA. Impact of sleep patterns on glycemic control in type 2 diabetes mellitus. *Al-Anbar Med J*. 2026;22(1). doi: 10.33091/amj.2025.161334.2283.
17. Ghaemian N, Haji Ghazi Tehrani N, Nabahati M. Accuracy of mammography and ultrasonography and their BI-RADS in detection of breast malignancy. *Caspian J Intern Med*. 2021;12(4):573-579. doi: 10.22088/cjim.12.4.573.
18. Milos RI, Pipan F, Kalovidouri A, Clauser P, Kapetas P, Bernathova M, et al. The Kaiser score reliably excludes malignancy in benign contrast-enhancing lesions classified as BI-RADS 4 on breast MRI high-risk screening exams. *Eur Radiol*. 2020;30(11):6052-6061. doi: 10.1007/s00330-020-06945-z.
19. Nguyen DL, Myers KS, Oluyemi E, Mullen LA, Panigrahi B, Rossi J, et al. BI-RADS 3 Assessment on MRI: A lesion-based review for breast radiologists. *J Breast Imaging*. 2022;4(5):460-473. doi: 10.1093/jbi/wbac032.
20. Barrios CH. Global challenges in breast cancer detection and treatment. *Breast*. 2022;62:S3-S6. doi: 10.1016/j.breast.2022.02.003.
21. Wang Q, Fu F, Chen Y, Yang D, Zhang J, Yu H, et al. Application of the Kaiser score by MRI in patients with breast lesions by ultrasound and mammography. *Diagn Interv Radiol*. 2022;28(4):322-328. doi: 10.5152/dir.2022.201075.
22. Chen ZW, Zhao YF, Liu HR, Zhou JJ, Miao HW, Ye SX, et al. Assessment of breast lesions by the Kaiser score for differential diagnosis on MRI: the added value of ADC and machine learning modeling. *Eur Radiol*. 2022;32(10):6608-6618. doi: 10.1007/s00330-022-08899-w.

23. Mohammadzadeh S, Mohebbi A, Moradi Z, Abdi A, Mohammadi A, Hakim PK, et al. Diagnostic performance of Kaiser score in the evaluation of breast cancer using MRI: A systematic review and meta-analysis. *Eur J Radiol*. 2025;186:112055. doi: 10.1016/j.ejrad.2025.112055.
24. Meng L, Zhao X, Guo J, Lu L, Cheng M, Xing Q, et al. Evaluation of the differentiation of benign and malignant breast lesions using synthetic relaxometry and the Kaiser score. *Front Oncol*. 2022;12:964078. doi: 10.3389/fonc.2022.964078.
25. Woitek R, Spick C, Schernthaner M, Rudas M, Kapetas P, Bernathova M, et al. A simple classification system (the Tree flowchart) for breast MRI can reduce the number of unnecessary biopsies in MRI-only lesions. *Eur Radiol*. 2017;27(9):3799-809. doi: 10.1007/s00330-017-4755-6.
26. Rong X, Kang Y, Li Y, Xue J, Li Z, Yang G. Application of the Kaiser score on contrast-enhanced mammography in the differential diagnosis of breast lesions: comparison with breast magnetic resonance imaging. *Quant Imaging Med Surg*. 2024;14(8):5541-5554. doi: 10.21037/qims-24-593.