Artificial intelligence-augmented breast ultrasound: Advancing diagnostic precision and equity in cancer care-Kuwait

Michael A Masoomi, PhD, MRCP(Lon)[1,*], Latifa Al-Kandari, MD[1]

[1]Department of Radiology, ADAN Hospital, Kuwait

*Author for correspondence:
Email: masoomim@sky.com

Editorial

Breast cancer remains the most diagnosed malignancy among women worldwide and continues to be the leading cause of cancer-related deaths. In Kuwait, the disease accounts for 40.1% of all new female cancer cases according to the World Health Organization's Global Cancer Observatory (2022) [1], reflecting a pressing national health challenge. This high prevalence is further complicated by the country's relatively youthful female population, with a median age below 29 years [2], emphasizing the need for early, accurate, and accessible diagnostic strategies that balance detection sensitivity with specificity. Artificial intelligence (AI)-augmented ultrasound represents a transformative innovation that can reshape this landscape. It offers the potential to enhance diagnostic precision, reduce unnecessary biopsies, and standardize radiologic interpretation in a healthcare system that is both technologically progressive and centrally organized.

Breast ultrasound is an essential tool in the diagnostic evaluation of breast lesions, particularly among women with dense breast tissue—a common feature among younger women in Kuwait and throughout the Gulf region. Dense breast tissue not only limits the sensitivity of mammography but is also an independent risk factor for breast cancer development [3]. As a result, ultrasound often serves as the first-line imaging modality for symptomatic patients and a vital adjunct in screening. However, conventional handheld ultrasound (HHUS) remains highly operator-dependent, with considerable variability in lesion interpretation, low specificity, and a relatively low positive predictive value (PPV) of around 10% [4]. The American College of Radiology's Breast Imaging Reporting and Data System (BI-RADS) provides a standardized lexicon for ultrasound interpretation, yet categories such as BI-RADS 4A (low suspicion) and 4B (modest suspicion) continue to pose diagnostic dilemmas, with malignancy risks ranging between 2% and 95%. [5] This broad range often results in an overly cautious approach, where most of these lesions ultimately prove benign on histopathology [6]. The introduction of AI into ultrasound workflows offers a solution to this diagnostic uncertainty by introducing objectivity, reproducibility, and data-driven decision support. Recent advances in AI and machine learning (ML) have enabled systems capable of analyzing imaging features such as lesion shape, margin, echotexture, and posterior acoustic characteristics to generate a probabilistic assessment of malignancy. Among the leading examples is the Koios DS for Breast (Koios Medical), a decision-support software cleared by the United States Food and Drug Administration (FDA). This system applies ML algorithms trained on large, annotated ultrasound datasets and correlates image features with known histopathologic outcomes. It provides structured risk categories that align with BI-RADS classifications [6], offering radiologists an evidence-based tool to complement human interpretation. Instead of replacing radiologists, AI functions as a "second reader," augmenting human judgment by highlighting discordant cases or reclassifying low-risk lesions that might otherwise lead to unnecessary interventions.

Preliminary local unpublished institutional experience from Kuwait adds valuable perspective to this growing field. A retrospective study evaluated an AI-based decision-support system (KOIOS DS) for BI-RADS categorization and biopsy recommendations in breast ultrasound, using histopathology as the reference standard. The study included 283 patients with 323 breast lesions assessed between January 2022 and January 2025. All lesions were independently evaluated by radiologists and the FDA-cleared KOIOS AI platform. Diagnostic performance was analyzed at two BI-RADS positivity thresholds (≥4A/B and ≥4C), with sensitivity, specificity, positive predictive value, negative predictive value, overall accuracy, and receiver operating characteristic analysis. At the ≥4A/B threshold, radiologists and KOIOS demonstrated near-maximal sensitivity (98.2% and 96.4%, respectively), with KOIOS showing modestly higher specificity. At the ≥4C threshold, radiologists achieved higher sensitivity, while KOIOS demonstrated superior specificity and positive predictive value, suggesting potential to reduce unnecessary biopsies. Overall discriminative performance was higher for radiologists (AUC 0.97) than KOIOS (AUC 0.90; $p<0.001$), though AI performance remained clinically acceptable.

This localized experience mirrors international observations. A 2024 meta-analysis by Li *et al.* [7] reported pooled AUC values ranging from 0.64 to 0.79 for AI-assisted breast ultrasound. The study demonstrated that integrating deep learning (DL) with ultrasound yields high diagnostic accuracy in the adjunctive detection of breast cancer, while the fusion of DL with multimodal breast ultrasound provides superior diagnostic efficacy compared with B-mode ultrasound alone. Prior reader-study evidence showed that AI assistance reduced false-positive findings and requested biopsies down 27.8% without sacrificing sensitivity in breast ultrasound interpretation [8]. Radiomics-based AI systems, which quantify texture, margin irregularity, and acoustic attenuation patterns imperceptible to human observers, represent the next frontier in this domain. These quantitative approaches may convert categorical BI-RADS assessments into continuous malignancy-risk scales, refining clinical decision-making and supporting personalized diagnostic pathways [9].

The regional context reinforces Kuwait's need to embrace such innovation. In Saudi Arabia, breast cancer constitutes 29% of all female cancers [10], while in the United Arab Emirates, more than a quarter of new cases occur in women younger than 45 years [11]. These epidemiologic parallels suggest that Gulf populations share distinctive breast cancer profiles characterized by early onset, dense breast tissue, and high-risk occupational and lifestyle factors. Consequently, diagnostic strategies and AI models trained on Western datasets may require adaptation and retraining to ensure relevance to Middle Eastern demographics. Kuwait's healthcare infrastructure, characterized by centralized management and strong digital integration, provides an ideal setting for population-specific validation of AI technologies. Such validation would ensure that AI tools are calibrated to the imaging characteristics and disease prevalence of the Kuwaiti population, thus enhancing both performance and clinical acceptance.

AI adoption also aligns closely with the broader national development agenda under Kuwait Vision 2035: New Kuwait, which identifies healthcare digitalization and innovation as key pillars for national progress [12]. Integrating AI into radiology services could reduce regional disparities in diagnostic access and quality by enabling consistent, evidence-based assessments across public and private hospitals. Moreover, AI implementation could help mitigate the shortage of breast-imaging specialists in Kuwait by supporting general radiologists with automated decision guidance. This, in turn, would improve diagnostic throughput, reduce radiologist fatigue, and enhance overall workflow efficiency.

However, technological innovation must be accompanied by robust clinical governance and ethical oversight. The American College of Radiology (ACR) and European Society of Breast Imaging (EUSOBI) emphasize the necessity of rigorous algorithm validation, bias control, and post-deployment monitoring [13]. Establishing a national AI oversight committee within Kuwait's Ministry of Health would ensure that such standards are upheld. This committee could supervise local calibration, monitor diagnostic concordance between AI outputs and human readers, and manage data privacy under ethical frameworks aligned with global standards such as the General Data Protection Regulation (GDPR). Implementation of AI performance dashboards within hospitals could further enhance transparency by tracking false-positive rates, biopsy-avoidance metrics, and long-term diagnostic outcomes.

Beyond diagnostic support, AI promises to play an increasingly predictive role in oncology. Deep-learning and radiomics models are now being trained to infer molecular subtypes of breast cancer—such as estrogen-receptor, progesterone-receptor, and human epidermal growth factor receptor 2 (HER2) status—from ultrasound imaging features alone. These developments, validated in multicenter studies, indicate that imaging-based AI could complement pathology in tailoring personalized treatment strategies [14]. For Kuwait, where national cancer registries are well established and patient follow-up is centralized, integrating predictive AI could accelerate the transition toward precision oncology.

The ethical and educational dimensions of AI implementation must not be overlooked. Effective adoption requires radiologists and technologists to understand algorithmic principles, interpret probabilistic outputs, and recognize potential system limitations. Incorporating AI literacy into radiology residency and continuing-education programs would foster safe and informed use. Ethical stewardship also demands transparency in algorithm design, equitable data representation, and proactive bias mitigation to prevent differential diagnostic performance across demographic groups.

Taken together, these developments signify a paradigm shift in breast imaging. AI-augmented ultrasound does not replace radiologists—it empowers them. By combining the interpretive expertise of clinicians with algorithmic precision, diagnostic accuracy can be enhanced while maintaining patient-centered care. The integration of AI into Kuwait's breast-imaging workflow aligns with both clinical imperatives and strategic national goals, supporting early detection, efficient resource utilization, and equitable healthcare delivery. As the technology matures, prospective multicenter trials across Kuwait and neighboring Gulf countries should assess long-term outcomes, interobserver variability, and cost-effectiveness.

Ultimately, AI-augmented breast ultrasound embodies the principles of precision medicine: the right test for the right patient, at the right time. Its adoption in Kuwait represents not only a response to clinical necessity but a forward-looking commitment to innovation and equity in women's health. Through structured implementation, governance, and education, Kuwait can emerge as a regional leader in AI-driven radiology, transforming the early detection of breast cancer from an art of interpretation into a science of precision.

References

1. World Health Organization (WHO). Global Cancer Observatory: Kuwait Fact Sheet. Lyon, France: International Agency for Research on Cancer; 2022. Available at: https://gco.iarc.who.int/.

2. Central Statistical Bureau (CSB), Kuwait. Demographic Indicators 2023. Kuwait City, Kuwait: CSB; 2023. Available at: https://www.csb.gov.kw.

3. Fruchtman Brot H, Mango VL. Artificial intelligence in breast ultrasound: application in clinical practice. Ultrasonography. 2024 Jan;43(1):3–14.

4. Berg WA, Blume JD, Cormack JB, Mendelson EB. Operator dependence of physician-performed whole-breast US: lesion detection and characterization. Radiology. 2006 Nov;241(2):355–65.

5. Mendelson EB, Böhm-Vélez M, Berg WA, Whitman GJ, Feldman MI, Madjar H. Acr bi-rads® ultrasound. ACR BI-RADS® atlas, breast imaging reporting and data system. 2013;2013.

6. Mango VL, Sun M, Wynn RT, Ha R. Should We Ignore, Follow, or Biopsy? Impact of Artificial Intelligence Decision Support on Breast Ultrasound Lesion Assessment. AJR Am J Roentgenol. 2020 Jun;214(6):1445–52.

7. Li H, Zhao J, Jiang Z. Deep learning-based computer-aided detection of ultrasound in breast cancer diagnosis: A systematic review and meta-analysis. Clin Radiol. 2024 Nov;79(11):e1403–13.

8. Shen Y, Sahmoud FE, Oliver JR, Witowski J, Kannan K, Park J, et al. Artificial intelligence system reduces false-positive findings in the interpretation of breast ultrasound exams. Nature Communications. 2021;12(1):5645.

9. Yang L, Zhang N, Jia J, Ma Z. Deep learning radiomics on grayscale ultrasound images assists in diagnosing benign and malignant of BI-RADS 4 lesions. Sci Rep. 2024 Dec 28;14(1):31479.

10. Saudi Cancer Registry. Cancer Incidence Report Saudi Arabia 2021. Riyadh: Ministry of Health; 2023. Available at: https://nhic.gov.sa/en/eServices/Pages/TumorRegistration.aspx.

11. United Arab Emirates Ministry of Health and Prevention. UAE Cancer Control Program: Annual Report 2022. Abu Dhabi: UAE MOHAP; 2023. Available at: https://mohap.gov.ae/en/Pages/default.aspx.

12. Government of Kuwait. Vision 2035: New Kuwait. Kuwait City, Kuwait. Accessed October 8, 2025. Available from: Available at: https://www.newkuwait.gov.kw.

13. Brady AP, Allen B, Chong J, Kotter E, Kottler N, Mongan J, et al. Developing, Purchasing, Implementing and Monitoring AI Tools in Radiology: Practical Considerations. A Multi-Society Statement From the ACR, CAR, ESR, RANZCR & RSNA. J Am Coll Radiol. 2024 Aug;21(8):1292–310.

14. Luo S, Chen X, Yao M, Ying Y, Huang Z, Zhou X, et al. Intratumoral and peritumoral ultrasound-based radiomics for preoperative prediction of HER2-low breast cancer: a multicenter retrospective study. Insights Imaging. 2025 Mar 7;16(1):53.