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Scientific Abstracts, Poster Presentations, Conference Recommendations and Highlights

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Editorial

Artificial Intelligence–Augmented Breast Ultrasound: Advancing Diagnostic Precision and Equity in Cancer Care in Kuwait

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Abstract:

Breast cancer poses a significant public health concern in Kuwait, accounting for **37.4%** of all newly diagnosed female cancer cases as reported by the Kuwait National Cancer Registry. The rising incidence, coupled with variability in imaging expertise, contributes to diagnostic delays and disparities in patient care. Artificial intelligence (AI) has rapidly become a transformative tool supporting breast ultrasound, enhancing diagnostic accuracy, standardization, and assistance for non–specialist providers. This editorial evaluates the potential of AI–enabled ultrasound to improve diagnostic performance by increasing sensitivity, decreasing false positive rates, and reducing inter–observer variability, while also addressing structural inequities that affect cancer outcomes within the region. Recent advancements in deep learning and radiomics–based tools are reviewed, alongside considerations related to governance and ethics, and recommendations for practical integration of AI solutions into national breast cancer management pathways are provided. The adoption of AI–augmented ultrasound holds considerable promise for strengthening Kuwait's capacity for early detection and advancing equitable, high–quality cancer care.

Editorial

Breast cancer is the most common malignancy among women in Kuwait, accounting for 37.4% of all newly diagnosed female cancers, according to the Kuwait National Cancer Registry 2019 report [1]. 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. Despite the availability of screening programs, a significant proportion of patients continue to present stage II or III disease, often with lymph node involvement, highlighting ongoing challenges in early detection and screening uptake [3].

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 [4]. 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% [5].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%[6]. This broad range often results in an overly cautious approach, where most of these lesions ultimately prove benign on histopathology [7]. 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 [7], 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 Clinical experience from Kuwait (will be published) adds valuable perspective to this growing field. A recent retrospective study analyzed 283 ultrasound scans from 323 breast lesions acquired between January 2022 and January 2024. Radiologists in this study achieved a high sensitivity of 98.2% but a comparatively lower specificity of 78.8%, suggesting a tendency toward overcalling in order to minimise missed cancers. The positive predictive value (PPV) was 90.6%, with an overall diagnostic accuracy of 91.6%, reflecting the trade–off associated with a more defensive diagnostic approach. In contrast, Koios DS demonstrated a sensitivity of 96.4% and a higher specificity of 82.2%, with a PPV of 92.1% and an overall accuracy of 92.0%. The AI system's receiver operating characteristic (ROC) area under the curve (AUC) was 0.90 compared to 0.97 for radiologists. The DeLong test demonstrates that the difference in AUC between radiologist and KOIOS is statistically significant, with radiologist BI–RADS showing superior overall discriminative performance for differentiating malignant from benign lesions. Despite this difference, the performance of KOIOS remained within a clinically acceptable range, reinforcing a complementary diagnostic paradigm in which artificial intelligence augments radiologist expertise by improving consistency and sensitivity across diagnostic thresholds.

This localized experience is supported by international observations. A 2024 meta–analysis by Li *et al.* [8] 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 [9]. 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 [10].

The regional context reinforces Kuwait's need to embrace such innovation. In Saudi Arabia, breast cancer constitutes 29% of all female cancers [11], while in the United Arab Emirates, more than a quarter of new cases occur in women younger than 45 years [12]. 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 [13]. 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 [14]. 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 [15]. 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.

Competing Interests Statement: The authors declare no competing interests.

Twit version: AI–augmented breast ultrasound can improve diagnostic precision, reduce variability, and support more equitable cancer care in Kuwait. This editorial highlight emerging evidence, governance needs, and the promise of responsible AI integration.

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