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Diagnostic Performance of AI-Assisted Ultrasound in Thyroid Nodule Detection in China

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Abstract

The widespread use of high-resolution ultrasound has led to a marked increase in the detection of thyroid nodules in China, making ultrasound a cornerstone of initial evaluation and risk assessment. However, conventional thyroid ultrasound is highly dependent on operator experience and subjective interpretation of sonographic features, which can result in variability in diagnostic performance across different clinical settings. These challenges are particularly evident in high-volume practices and resource-limited environments, where consistency and efficiency are difficult to maintain. In this context, artificial intelligence–assisted ultrasound has emerged as a supportive technology designed to enhance standardization and reliability in thyroid nodule detection. This paper presents a conceptual evaluation of the diagnostic performance of AI-assisted ultrasound within the Chinese healthcare system, focusing on its potential influence on sensitivity, specificity, diagnostic consistency, and clinical decision-making. Rather than reporting original empirical data, the discussion examines how AI-assisted tools may reduce inter-operator variability, support clinicians with differing levels of experience, and integrate into existing clinical workflows across primary care, tertiary hospitals, and large-scale screening programs. Challenges related to model generalizability, data quality, interpretability, and ethical considerations are also addressed. By situating AI-assisted ultrasound within real-world clinical practice, this paper aims to clarify its potential role, limitations, and future significance in thyroid nodule management in China.

Keywords: AI-assisted ultrasound, thyroid nodule detection, diagnostic performance, clinical decision support, ultrasound imaging

1. Introduction

With the increasing use of high-resolution ultrasound in routine clinical practice and population-based health screening, thyroid nodules are being detected with growing frequency in China. Many of these nodules are identified incidentally in asymptomatic individuals undergoing examinations for unrelated reasons, which has shifted thyroid ultrasound from a problem-oriented diagnostic test to a routine, high-volume procedure. As a result, ultrasound now occupies a central role in the initial evaluation, risk stratification, and follow-up of thyroid nodules across nearly all levels of the healthcare system.

Despite its widespread adoption, the diagnostic performance of conventional thyroid ultrasound remains strongly influenced by operator expertise. Accurate interpretation of sonographic features—including margin characteristics, echogenicity, shape, and calcification patterns—requires substantial training and clinical experience. Variability in how these features are perceived and weighted has been widely reported, leading to inconsistent assessments among radiologists and sonographers. In busy clinical environments, particularly in primary hospitals and community-based screening programs, time constraints and limited access to experienced specialists may further exacerbate these challenges. Such variability can affect not only diagnostic confidence but also downstream clinical decisions, including recommendations for follow-up, biopsy, or referral.

Against this background, artificial intelligence has been increasingly explored as a supportive technology in thyroid ultrasound. AI-assisted systems are designed to analyze ultrasound images in a standardized and reproducible manner, typically by identifying nodules, extracting predefined imaging features, and generating structured risk assessments. Importantly, these systems are not intended to replace clinicians or redefine diagnostic criteria. Instead, they are commonly positioned as decision-support tools that aim to reduce subjectivity, improve consistency, and assist clinicians—particularly those with less experience—in applying established assessment frameworks more reliably.

The potential relevance of AI-assisted ultrasound is especially pronounced in the Chinese healthcare context. Large patient volumes, uneven distribution of experienced radiologists, and substantial variation in institutional resources create conditions in which diagnostic consistency is difficult to maintain. In such settings, AI-assisted tools may offer a means of supporting more uniform evaluation standards while accommodating existing clinical workflows. At the same time, their integration raises practical questions related to clinician acceptance, workflow efficiency, and alignment with real-world diagnostic practices.

The present paper discusses the diagnostic performance of AI-assisted ultrasound in thyroid nodule detection in China from a conceptual perspective. Rather than focusing on original empirical validation, it examines the clinical rationale, potential benefits, and practical considerations associated with incorporating AI into thyroid ultrasound practice. By situating AI-assisted ultrasound within everyday clinical contexts, this paper seeks to clarify its potential value, limitations, and role in contemporary thyroid nodule management.

2. AI-Assisted Ultrasound for Thyroid Nodule Detection

AI-assisted ultrasound systems for thyroid nodule detection are most commonly implemented either as software modules integrated into conventional ultrasound equipment or as independent platforms capable of analyzing stored images. These systems are generally designed to fit within existing diagnostic routines, allowing clinicians to incorporate AI support without substantially altering established scanning workflows. Rather than introducing new diagnostic concepts, most AI models are developed to recognize and quantify sonographic features that are already central to routine thyroid nodule assessment, thereby maintaining continuity with current clinical practice.

At a technical level, AI-assisted image analysis relies on machine learning or deep learning algorithms trained on large datasets of labeled ultrasound images. Through this training process, the system learns to associate specific visual patterns—such as irregular or ill-defined margins, hypoechogenicity, taller-than-wide shape, and microcalcifications—with different levels of malignancy risk. In clinical application, AI systems typically perform automated tasks including nodule detection, boundary delineation, and feature extraction, followed by the generation of a structured risk evaluation. These results are often presented in formats familiar to clinicians, such as categorical risk stratification or probability-based scores, which facilitates interpretation and lowers barriers to clinical acceptance.

From a functional perspective, AI-assisted ultrasound can serve multiple complementary roles in thyroid nodule detection. One important function is acting as a second reader, providing an additional standardized assessment alongside the clinician’s interpretation. This supplementary input may help reinforce confidence when findings are concordant or prompt reconsideration when discrepancies arise. AI may also function as a quality-control mechanism by consistently evaluating image features and drawing attention to findings that might otherwise be overlooked, particularly during high-throughput examinations where time pressure is substantial.

In the context of clinical workflows in China, AI-assisted ultrasound is often deployed in settings characterized by high patient volume and variable levels of operator experience. In tertiary hospitals, AI tools may be used to support consistency among multiple examiners and reduce both intra- and inter-observer variability. In primary care institutions and community-based screening programs, where access to experienced thyroid specialists is more limited, AI-assisted systems are frequently viewed as a means of supporting less experienced clinicians by reinforcing guideline-based assessment and providing structured interpretive reference.

Despite these potential advantages, AI-assisted ultrasound is rarely applied as a standalone diagnostic solution. In routine practice, AI-generated assessments are typically considered in conjunction with grayscale ultrasound findings, Doppler information, and relevant clinical context. This integrative approach reflects current expectations that AI functions as a supportive component within clinician-led decision-making rather than as an autonomous diagnostic authority. Within this framework, the clinical value of AI-assisted ultrasound depends not only on algorithmic performance, but also on how effectively it aligns with real-world workflows, earns clinician trust, and adapts to the practical demands of thyroid nodule management in China.

3. Diagnostic Performance: Conceptual Evaluation

Rather than presenting original empirical findings, the diagnostic performance of AI-assisted ultrasound in thyroid nodule detection can be discussed conceptually through several key dimensions commonly used in clinical imaging. These dimensions help illustrate not only how performance is defined, but also how AI may influence diagnostic reasoning and clinical behavior in daily practice.

3.1 Sensitivity and Early Detection

Sensitivity is commonly used to describe the capacity of an AI-assisted system to identify thyroid nodules that may require further clinical attention. From a conceptual standpoint, AI-assisted ultrasound may contribute to improved sensitivity by applying predefined recognition rules in a uniform and uninterrupted manner across examinations. Unlike human operators, whose attention and performance can be influenced by fatigue, time pressure, or cumulative workload, AI systems maintain a consistent analytical focus. This characteristic is particularly relevant in high-volume ultrasound settings, where efficiency demands may increase the risk of missed findings.

The potential benefit of enhanced sensitivity is especially apparent in the detection of small nodules or lesions with subtle sonographic characteristics. Such nodules may not display prominent or classic malignant features and can therefore be overlooked during routine scanning, particularly when examinations are conducted rapidly or under constrained conditions. AI-assisted systems, by systematically evaluating image features across the entire field of view and applying the same detection criteria to each frame, may increase the likelihood that these less conspicuous abnormalities are identified and brought to the clinician's attention.

In addition, consistent sensitivity may help address variability in detection that arises from differences in operator experience. Less experienced clinicians may be more likely to miss subtle findings, whereas AI-assisted tools can provide a stable reference that supports more comprehensive initial assessments. In this sense, AI does not replace clinical observation but acts as an additional layer of vigilance that complements human interpretation.

Early detection also carries implications for downstream clinical management. Identification of nodules at an earlier stage may influence decisions regarding follow-up intervals, surveillance strategies, or the need for additional imaging and referral. Although increased sensitivity does not automatically translate into improved clinical outcomes, it conceptually supports a more complete baseline evaluation. Within this framework, AI-assisted ultrasound may function as a supplementary safeguard, helping ensure that potentially relevant findings are consistently recognized, documented, and incorporated into subsequent clinical decision-making processes.

3.2 Specificity and Reduction of Unnecessary Intervention

Specificity refers to the ability of an AI-assisted system to correctly identify thyroid nodules that are unlikely to be malignant or clinically significant. Conceptually, this aspect of diagnostic performance is closely linked to the system's capacity to limit false-positive assessments and to avoid unnecessary escalation of care. In routine clinical practice—particularly in screening programs and primary care settings—uncertainty in ultrasound interpretation often leads to conservative decision-making. This tendency may result in excessive follow-up imaging, fine-needle aspiration, or referral to higher-level institutions, even when the actual risk associated with a nodule is low.

AI-assisted ultrasound may contribute to improved specificity by reducing subjective overinterpretation of equivocal sonographic features. Human assessment of borderline findings, such as mildly irregular margins, heterogeneous echogenicity, or indeterminate internal composition, can vary substantially depending on individual experience, diagnostic confidence, and risk tolerance. In contrast, AI systems apply standardized assessment frameworks consistently across cases, which may help place such features into a more balanced and reproducible risk context. By discouraging overestimation of malignancy potential when findings do not clearly meet high-risk criteria, AI-assisted tools may help stabilize diagnostic thresholds.

The potential reduction in unnecessary intervention carries practical implications for both patients and healthcare systems. For patients, avoiding unwarranted procedures may reduce anxiety, physical discomfort, and exposure to procedural risks, while also limiting the psychological burden associated with repeated testing. For healthcare systems—particularly those managing large screening populations or operating under resource constraints—improved specificity may help optimize the use of diagnostic and specialist services, allowing attention to be focused on patients with higher-risk findings.

From a broader clinical perspective, AI-assisted ultrasound may support more proportionate and individualized management strategies. By helping clinicians distinguish low-risk nodules suitable for observation from those that genuinely warrant further investigation, AI tools can contribute to more rational follow-up planning and resource allocation. Importantly, improved specificity does not imply rigid adherence to AI-generated output. Instead, AI-assisted assessments may serve as a stabilizing reference that complements clinical judgment, particularly in situations where uncertainty might otherwise prompt overly cautious management. In this way, AI-assisted ultrasound may help refine decision-making while preserving clinician responsibility and oversight.

3.3 Standardized Interpretation of Sonographic Features

Interpretation of sonographic features such as margins, echogenicity, shape, and internal composition is fundamental to thyroid nodule evaluation, yet it remains one of the most subjective components of ultrasound diagnosis. Even when standardized reporting terminology is applied, clinicians may differ in how individual features are perceived, emphasized, and integrated into an overall risk assessment. These differences are shaped by variations in training background, accumulated clinical experience, and local practice patterns, and they can result in inconsistent diagnostic conclusions for nodules with similar imaging appearances.

From a conceptual perspective, AI-assisted ultrasound offers a standardized approach to feature interpretation by applying the same analytical criteria uniformly across cases. Rather than relying solely on individual visual judgment, AI systems evaluate image characteristics according to predefined patterns learned from large and annotated datasets. This process allows features to be assessed in a consistent manner, independent of examiner subjectivity. In cases where sonographic findings are subtle or do not clearly align with high- or low-risk categories, AI-assisted analysis may provide a more stable interpretive reference, helping to reduce ambiguity in risk stratification.

The value of such standardization becomes particularly apparent in clinical environments where multiple examiners are involved in patient care. In high-volume departments, variability in feature interpretation can complicate communication among clinicians, hinder consistent follow-up planning, and affect the reliability of longitudinal comparisons. By promoting more uniform interpretation of similar imaging features, AI-assisted assessments may support clearer documentation and more coherent clinical decision-making across providers.

This benefit may extend across institutions as well. In healthcare systems characterized by substantial institutional diversity, such as those in China, differences in ultrasound equipment, scanning protocols, and operator expertise can further amplify interpretive variability. Conceptually, AI-assisted ultrasound may help bridge these differences by introducing a shared analytical framework that supports more comparable assessments across centers. Within this context, standardized feature interpretation does not replace clinical judgment but serves as a common reference point, enhancing clarity, consistency, and confidence in thyroid nodule evaluation while preserving clinician autonomy.

3.4 Inter-Operator Variability and Diagnostic Consistency

Inter-operator variability is a well-recognized limitation of conventional thyroid ultrasound and represents a persistent challenge in routine clinical practice. Even when standardized reporting systems and risk stratification frameworks are available, differences in training background, years of experience, and individual diagnostic thresholds can lead to divergent interpretations of the same lesion. Such variability may influence not only the initial assessment of malignancy risk but also downstream management decisions, including recommendations for follow-up intervals, fine-needle aspiration, or surgical referral.

AI-assisted ultrasound systems have the potential to mitigate this variability by generating stable and repeatable outputs based on uniform analytical processes. Conceptually, AI applies the same evaluation criteria to image analysis regardless of who performs the examination, reducing reliance on individual subjective judgment alone. This characteristic may be particularly valuable in high-volume clinical environments, where examinations are conducted by multiple operators with heterogeneous levels of experience and where maintaining consistent diagnostic standards can be challenging.

Diagnostic consistency is especially important in the context of longitudinal follow-up. Thyroid nodules are often monitored over extended periods, and reliable comparison across serial examinations is essential for determining true nodule progression or stability. When follow-up scans are performed by different clinicians or at different institutions, variability in feature interpretation can obscure meaningful change and complicate clinical decision-making. By providing a consistent interpretive reference, AI-assisted ultrasound may support more reliable longitudinal evaluation, helping clinicians distinguish genuine morphological changes from differences attributable to observer interpretation.

From a conceptual perspective, improved consistency does not imply uniformity at the expense of clinical nuance. AI-assisted systems are not intended to override contextual judgment or clinical reasoning. Instead, they may serve as an anchoring reference that promotes coherence in interpretation across time, personnel, and clinical settings. In this role, AI contributes to diagnostic continuity while allowing clinicians to retain responsibility for integrating imaging findings with clinical context, particularly in cases that are borderline, atypical, or clinically complex.

3.5 Contribution to Clinical Decision-Making

Beyond isolated performance metrics, the diagnostic value of AI-assisted ultrasound can also be understood in terms of how it supports clinical decision-making. In routine practice, interpretation of thyroid ultrasound findings often involves a degree of uncertainty, particularly when sonographic features do not clearly fall into high- or low-risk categories. In such situations, AI-assisted systems may function as a secondary reference point that complements, rather than replaces, clinician judgment.

When AI-assisted assessments are concordant with the clinician's initial interpretation, they may reinforce diagnostic confidence and support timely decision-making. This reinforcement can be particularly useful in high-volume clinical environments, where efficiency and consistency are essential. Conversely, when discrepancies arise between AI output and human assessment, the divergence itself may prompt more careful review of imaging features, encouraging clinicians to re-examine assumptions rather than proceed reflexively.

This role is especially relevant in complex or borderline cases, where immediate categorical conclusions may not be appropriate. AI-assisted ultrasound can provide structured input—such as probabilistic risk estimates or standardized classifications—that helps frame uncertainty in a more explicit manner. By making risk more transparent, AI may support more nuanced clinical discussions regarding follow-up strategies, additional testing, or referral decisions.

From a conceptual standpoint, the contribution of AI-assisted ultrasound to clinical decision-making lies in its ability to support deliberation rather than dictate outcomes. By acting as an adjunctive analytical layer, AI may help clinicians balance caution with restraint, particularly in cases where management decisions depend on subtle imaging distinctions. In this context, diagnostic performance is reflected not only in accuracy, but in how effectively AI assists clinicians in making informed, context-sensitive decisions within established clinical pathways.

3.6 Interaction with Operator Experience

The impact of AI-assisted ultrasound on diagnostic performance is closely linked to the experience level of the operator. In thyroid ultrasound, differences in training and clinical exposure can substantially influence how sonographic features are recognized, interpreted, and translated into management decisions. As a result, the same AI-assisted output may serve different practical roles depending on who is using it.

For less experienced clinicians, AI-assisted ultrasound may provide structured guidance that aligns with established diagnostic criteria. In early stages of training or in settings with limited mentorship, AI outputs can offer reassurance and help frame image interpretation within a standardized risk assessment approach. This support may reduce uncertainty and narrow the gap between novice and expert interpretation, particularly when evaluating borderline or unfamiliar imaging patterns. Conceptually, AI functions as a reference that reinforces learning and promotes adherence to consistent assessment principles.

For experienced radiologists, the role of AI-assisted ultrasound is often different. Rather than serving as primary guidance, AI may act as a consistency check or quality assurance tool. Experienced clinicians typically rely on pattern recognition and contextual judgment developed over time, but AI outputs may still be valuable in highlighting discrepancies, confirming impressions, or prompting reconsideration in atypical cases. In this context, AI does not substitute expertise but provides an additional layer of verification that supports diagnostic confidence and consistency.

This interaction underscores that diagnostic performance does not arise solely from algorithmic capability or human expertise in isolation. Instead, it emerges from the collaboration between clinicians and AI systems, shaped by experience, context, and workflow. Conceptually, the effectiveness of AI-assisted ultrasound depends on how well it complements different levels of operator expertise and integrates into existing diagnostic practices, rather than on uniform performance gains across all users.

4. Clinical Implications in the Chinese Healthcare Context

The potential clinical implications of AI-assisted ultrasound for thyroid nodule management in China are closely tied to the structure and demands of the national healthcare system. Thyroid ultrasound is performed across a wide range of settings, from tertiary referral hospitals to primary care institutions and large-scale health screening centers. This broad deployment creates marked variation in operator experience, diagnostic resources, and clinical workflow, all of which shape how AI-assisted tools may be used in practice.

In primary care and resource-limited settings, access to experienced thyroid specialists is often limited, while patient volumes remain high. In these contexts, AI-assisted ultrasound may serve as a supportive tool that helps standardize initial assessments and reduce diagnostic uncertainty. By providing structured evaluations aligned with commonly accepted criteria, AI systems may assist clinicians in identifying nodules that warrant referral while avoiding unnecessary escalation of low-risk findings. This supportive role could contribute to more efficient use of specialist resources and improve continuity of care across different levels of the healthcare system.

AI-assisted ultrasound also has potential implications for large-scale screening programs, which are increasingly common in China. High-throughput screening environments place significant pressure on clinicians to maintain consistency and accuracy under time constraints. In such settings, AI tools may help maintain baseline diagnostic quality by offering consistent reference assessments and reducing the likelihood of oversight. While AI is unlikely to replace clinician judgment in screening decisions, its integration may contribute to more uniform evaluation standards across large populations.

Beyond technical performance, clinician acceptance is a critical factor influencing the real-world impact of AI-assisted ultrasound. In practice, acceptance is shaped not only by perceived accuracy, but also by transparency, ease of use, and alignment with existing diagnostic habits. Systems that present outputs in familiar formats and integrate smoothly into established workflows are more likely to be adopted. Conversely, tools that disrupt scanning routines or produce opaque results may encounter resistance, regardless of their technical capability.

Workflow integration is equally important in determining clinical value. In busy outpatient environments, AI-assisted ultrasound must function without significantly extending examination time or adding cognitive burden. Effective integration requires that AI outputs complement rather than compete with real-time image interpretation, allowing clinicians to incorporate AI feedback naturally into their decision-making process.

Regulatory and governance considerations also shape the clinical implications of AI-assisted ultrasound in China. As AI technologies continue to enter clinical practice, issues related to data governance, system validation, and clinical responsibility remain under active discussion. Clear regulatory frameworks and standardized evaluation pathways are essential to ensure that AI-assisted tools are used safely and consistently across institutions. Within this evolving landscape, the clinical impact of AI-assisted ultrasound will depend not only on algorithmic performance, but also on how effectively these systems are embedded within regulatory, institutional, and professional structures.

The clinical implications of AI-assisted ultrasound in China extend beyond technical enhancement of thyroid nodule detection. Their significance lies in how they interact with existing healthcare realities, support clinicians across diverse settings, and contribute to more consistent and efficient thyroid nodule management within the broader healthcare system.

5. Challenges and Limitations

Despite the growing interest in AI-assisted ultrasound for thyroid nodule detection, several challenges and limitations must be considered when evaluating its role in clinical practice. One central concern relates to model generalizability. Many AI systems are trained on datasets derived from specific institutions, devices, or patient populations. Differences in ultrasound equipment, scanning protocols, and patient characteristics across regions may limit the reliability of these systems when applied beyond their original development settings. In a country as geographically and demographically diverse as China, this lack of generalizability represents a significant practical constraint.

Data quality is another critical issue influencing the performance of AI-assisted ultrasound. Ultrasound images are inherently operator-dependent, and variability in image acquisition can affect algorithmic output. Inconsistent labeling standards, heterogeneous annotation quality, and imbalanced datasets may further introduce bias into AI models. These challenges are particularly relevant in large-scale, multi-level healthcare systems, where data are collected under varying conditions and levels of expertise.

Interpretability also remains a key limitation. While AI-assisted systems may provide risk scores or classifications, the underlying decision-making processes are often not fully transparent to clinicians. This lack of interpretability can hinder trust and limit clinical adoption, especially when AI outputs conflict with human judgment. In thyroid ultrasound, where nuanced interpretation of features often guides management decisions, clinicians may be reluctant to rely on recommendations that cannot be clearly explained or contextualized.

Ethical and governance considerations further complicate the integration of AI-assisted ultrasound into routine practice. Issues related to data privacy, informed consent, and accountability in cases of diagnostic error remain areas of ongoing discussion. In the Chinese healthcare context, where digital health technologies are rapidly expanding, the balance between innovation and regulation is still evolving. Clear guidelines regarding responsibility for AI-assisted decisions and standardized evaluation frameworks are essential to ensure safe and equitable use.

Finally, the clinical effectiveness of AI-assisted ultrasound is closely linked to how these systems are implemented rather than to algorithmic performance alone. Overreliance on AI outputs may risk deskilling clinicians, while insufficient integration may limit practical benefit. These limitations highlight the need for cautious, context-aware adoption of AI-assisted ultrasound, with attention to technical, clinical, and ethical factors that shape its real-world impact within the Chinese healthcare system.

6. Future Perspectives

Future development of AI-assisted ultrasound in thyroid imaging is likely to focus on advancing both technical capability and depth of clinical integration. One important direction involves further optimization of AI systems through the use of more diverse and representative training datasets. Incorporating ultrasound images acquired across different geographic regions, healthcare institutions, equipment manufacturers, and patient populations may help improve model robustness and generalizability. This consideration is particularly important in China, where substantial heterogeneity exists in clinical practice patterns, imaging quality, and patient demographics.

Another key perspective concerns closer alignment between AI-assisted ultrasound systems and established clinical guidelines. Rather than functioning as parallel or supplementary assessment tools, future AI models may increasingly be designed to mirror guideline-based diagnostic pathways, such as structured risk stratification systems. Explicit alignment with widely accepted frameworks could enhance interpretability and clinician trust, making AI outputs easier to integrate into routine decision-making. When AI recommendations correspond directly to familiar clinical categories and management pathways, their practical utility and acceptance are likely to increase.

Integration of AI-assisted ultrasound with broader clinical information also represents an important area for future development. Current systems are largely image-centric, focusing on visual pattern recognition alone. Future models may incorporate additional clinical variables, including patient age, sex, laboratory findings, medical history, and prior imaging results. This multimodal approach has the potential to produce more context-aware assessments that better reflect real-world clinical reasoning, moving beyond isolated image interpretation toward more comprehensive decision support.

Personalized risk assessment is a particularly promising direction in thyroid nodule management. Clinical decisions often depend not only on imaging features but also on patient-specific factors and follow-up considerations. AI systems capable of adapting risk estimates to individual profiles may support more tailored management strategies, such as personalized surveillance intervals or intervention thresholds. Such developments would represent a shift from population-level pattern recognition toward patient-centered risk modeling, aligning AI-assisted ultrasound more closely with individualized care.

Finally, progress in this field will depend not only on technological innovation but also on sustained evaluation in real-world clinical environments. Prospective assessment, post-deployment monitoring, and ongoing collaboration among clinicians, researchers, and regulatory bodies will be essential to ensure that AI-assisted ultrasound evolves in a manner that is clinically meaningful, ethically responsible, and aligned with the practical needs of thyroid care in China.

7. Conclusion

AI-assisted ultrasound represents a promising supportive approach for the detection and management of thyroid nodules, particularly within the context of China’s high-volume, multi-tiered healthcare system. By providing standardized image analysis and structured risk assessment, AI-assisted tools have the potential to improve diagnostic reliability and reduce variability associated with operator experience. These advantages are especially relevant in settings where thyroid ultrasound is performed frequently and by clinicians with heterogeneous levels of training.

Rather than functioning as a replacement for clinician expertise, AI-assisted ultrasound is best understood as a complementary technology that augments conventional ultrasound practice. Its primary value lies in enhancing consistency, supporting less experienced operators, and reinforcing guideline-based assessment. In primary care institutions and large-scale screening programs, where diagnostic resources and specialist availability are unevenly distributed, AI-assisted systems may help promote more uniform evaluation standards while preserving clinician oversight and judgment.

At the same time, the clinical impact of AI-assisted ultrasound depends on careful and context-sensitive implementation. Effective integration into real-world workflows, transparent system design, and appropriate regulatory oversight are essential to ensure safe and meaningful use. Without alignment to clinical routines and professional expectations, even technically robust AI systems may fail to deliver practical benefit. Continued refinement, validation in diverse clinical environments, and active engagement with clinicians will therefore remain critical components of successful adoption.

AI-assisted ultrasound has the potential to play an important role in contemporary thyroid imaging in China. Its long-term value will depend not only on algorithmic performance, but also on how well it complements human expertise, adapts to healthcare system realities, and supports informed, patient-centered decision-making in thyroid nodule management.

References

Buda, M., Wildman-Tobriner, B., Hoang, J. K., Thayer, D., Tessler, F. N., Middleton, W. D., & Mazurowski, M. A. (2019). Management of thyroid nodules seen on ultrasound images: Deep learning may match performance of radiologists. *Radiology, 292*(3), 695–701.

Cai, X., Zhou, Y., Ren, J., Wei, J., Lu, S., & Gu, H. (2025). Intelligent diagnosis of thyroid nodules with AI ultrasound assistance and cytology classification. *Frontiers in Endocrinology, 16*.

Kim, H. L., Ha, E. J., & Han, M. (2019). Real-world performance of computer-aided diagnosis system for thyroid nodules using ultrasonography. *Ultrasound in Medicine & Biology, 45*(10), 2672–2678.

Ko, S. Y., Lee, J. H., Yoon, J. H., Kim, E. K., Moon, H. J., & Kwak, J. Y. (2019). Deep convolutional neural network for the diagnosis of thyroid nodules on ultrasound. *Head & Neck, 41*(4), 885–891.

Li, Y., Li, X., Yan, L., Xiao, J., Yang, Z., Zhang, M., & Luo, Y. (2025). Multiparametric ultrasound techniques are superior to AI-assisted ultrasound for assessment of solid thyroid nodules: A prospective study. *Endocrine, 78*(1), 112–121.

Li, Y., Ma, J., Zhou, T., Sun, Z., Wang, L., Yu, X., & Xu, Z. (2025). A narrative review on innovations of thyroid nodule ultrasound diagnosis: Applications of robot and artificial intelligence technology. *Frontiers in Endocrinology, 16*.

Park, V. Y., Han, K., Seong, Y. K., Park, M. H., Moon, W. J., & Kwak, J. Y. (2019). Diagnosis of thyroid nodules: Performance of a deep learning convolutional neural network model vs radiologists. *Radiology, 293*(2), 403–411.

Peng, S., Liu, Y., Lv, W., Liu, L., Zhou, Q., & Yang, H. (2021). Deep learning–based artificial intelligence model to assist thyroid nodule diagnosis and management: A multicentre diagnostic study. *The Lancet Digital Health, 3*(4), e250–e259.

Song, J., Chai, Y., Masuoka, H., Park, S. W., Kim, S. J., Choi, J. Y., & Kong, H. J. (2019). Ultrasound image analysis using deep learning algorithm for the diagnosis of thyroid nodules. *Medicine, 98*(15), e15133.

Wang, J., Zheng, N., Wan, H., Yao, Q., & Jia, S. (2024). Deep learning models for thyroid nodules diagnosis of fine-needle aspiration biopsy: A retrospective, prospective, multicentre study in China. *The Lancet Digital Health, 6*(3), e215–e226.

Wu, M., Cui, X., Li, Y., Li, T., He, K., & Liu, Z. (2025). Accurate thyroid nodule classification with explainable ultrasound image analysis: An AI tool. *Ultrasound in Medicine & Biology, 51*(4), 1023–1034.

Xu, D., Sui, L., Zhang, C., Xiong, J., Wang, V. Y., & Zhou, Y. (2024). The clinical value of artificial intelligence in assisting junior radiologists in thyroid ultrasound: A multicenter prospective study from real clinical practice. *BMC Medicine, 22*.

Xue, Y., Zhou, Y., Wang, T., Chen, H., & Wu, L. (2022). Accuracy of ultrasound diagnosis of thyroid nodules based on artificial intelligence–assisted diagnostic technology: A systematic review and meta-analysis. *BioMed Research International, 2022*.

Zhan, J., Zhang, J., Zhu, S., Ni, L., & Zhang, C. (2025). Diagnostic performance of ultrasound characteristics–based artificial intelligence models for thyroid nodules: A systematic review and meta-analysis. *Frontiers in Endocrinology, 16*.

Zhou, T., Xu, L., Shi, J., Zhang, Y., Lin, X., Wang, Y., & Hu, T. (2024). Ultrasound of thyroid nodules: Can an AI-assisted diagnostic system compete with fine-needle aspiration? *European Radiology, 34*(2), 1021–1031.