

Poster number (EP08.10). Fetal coarctation of aorta diagnosis with Human-Machine Collaboration: a clinical validation study based on a multi-view two-stage AI system

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Introduction

Fetal coarctation of the aorta (CoA) is one of the most challenging congenital heart diseases in prenatal diagnosis. Overdiagnosis may lead to unnecessary referral, intensified surveillance, and parental anxiety, whereas failure to identify fetuses who require early postnatal surgery may delay critical treatment. Therefore, a prenatal risk assessment tool for predicting postnatal surgical need is clinically needed.

Objective

This study aimed to develop and validate a two-stage artificial intelligence–assisted system based on multiple standard views for risk stratification in fetuses with prenatally suspected coarctation of the aorta, with the primary goal of predicting the need for CoA-related surgical repair within 12 months after birth. In addition, we evaluated whether AI assistance could improve three-class classification performance among ultrasound physicians with different levels of experience.

Methods

This single center retrospective study included 2,749 fetal echocardiographic examinations: 107 high-risk cases that underwent CoA-related surgery within 12 months after birth, 198 prenatally suspected but non-surgical low-risk cases, and 2,444 normal controls without structural cardiac abnormalities on prenatal or postnatal evaluation. The AI system integrated three standard fetal echocardiographic views — the 4CV, 3VT and Arch. First distinguish normal from suspected CoA cases and then stratify suspected cases into low-risk and high-risk groups. Model performance was assessed using 5-fold cross validation. In addition, an independent reader-study set of 105 fetuses was sampled from the study cohort. 20 ultrasound physicians with different levels of experience completed two rounds of blinded review, first without AI assistance and then with AI assistance, and their classification accuracy, predictive performance, error patterns, and inter-reader agreement were compared.

Results

The model showed stable performance across cross-validation, with mean AUCs of 0.984 in the screening stage and 0.995 in the risk discrimination stage; in the second stage, sensitivity, specificity, and F1 score were 0.945, 0.954, and 0.935, respectively. In the reader study, AI-provided structured decision support significantly improved physicians’ overall three-class risk classification accuracy from 0.632 to 0.738 (P < 0.001) and markedly reduced misclassification of low-risk cases as high-risk cases (from 335 to 209). The greatest benefit was observed among junior and intermediate-level physicians, whose AI-assisted performance approached that of fetal echocardiography specialists. In binary analysis targeting identification of the hig-risk group, AI assistance increased the positive predictive value from 0.465 to 0.590 while maintaining a high negative predictive value (0.933 vs 0.938). AI assistance also reduced mean reading time by approximately 23%, indicating improved workflow efficiency. The system further demonstrated generally stable performance across different gestational ages and images acquired from multiple ultrasound platforms.

Conclusion

This multi view two-stage AI system can assist surgical risk stratification in fetuses with prenatally suspected CoA. Its main clinical value lies in reducing overclassification of normal and low-risk cases as high-risk, thereby improving the reliability of high-risk assessment and sporting perinatal referral, delivery site planning, and postnatal monitoring decisions. The benefit of AI assistance was most evident among physicians with prior experience in obstetric ultrasound, whereas its effect in trainee physicians showed greater individual variability, suggesting that appropriate training and standardized use are essential for clinical implementation.

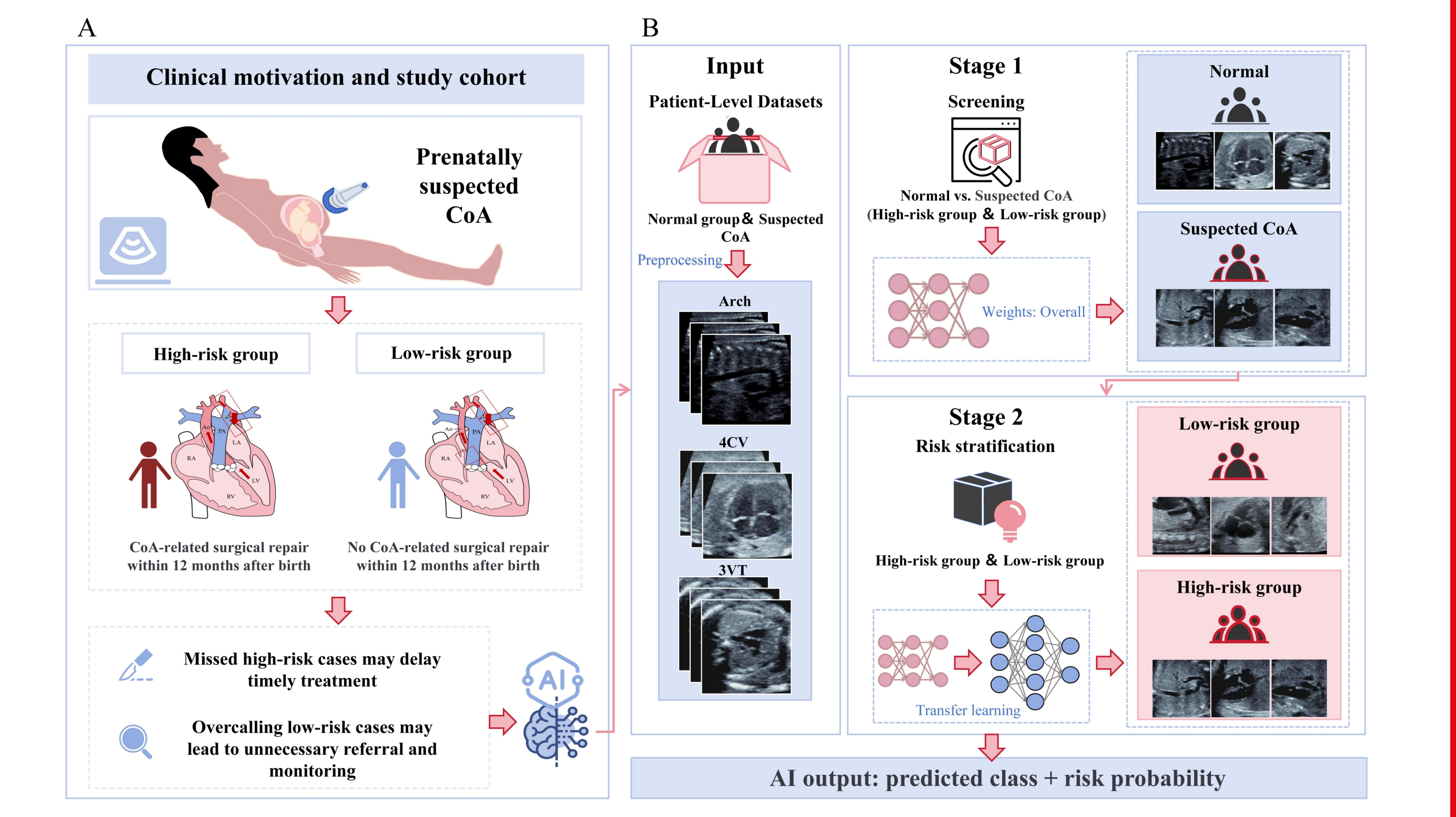


Figure 1. Clinical motivation and two-stage AI framework for prenatal CoA-related surgical-risk stratification.

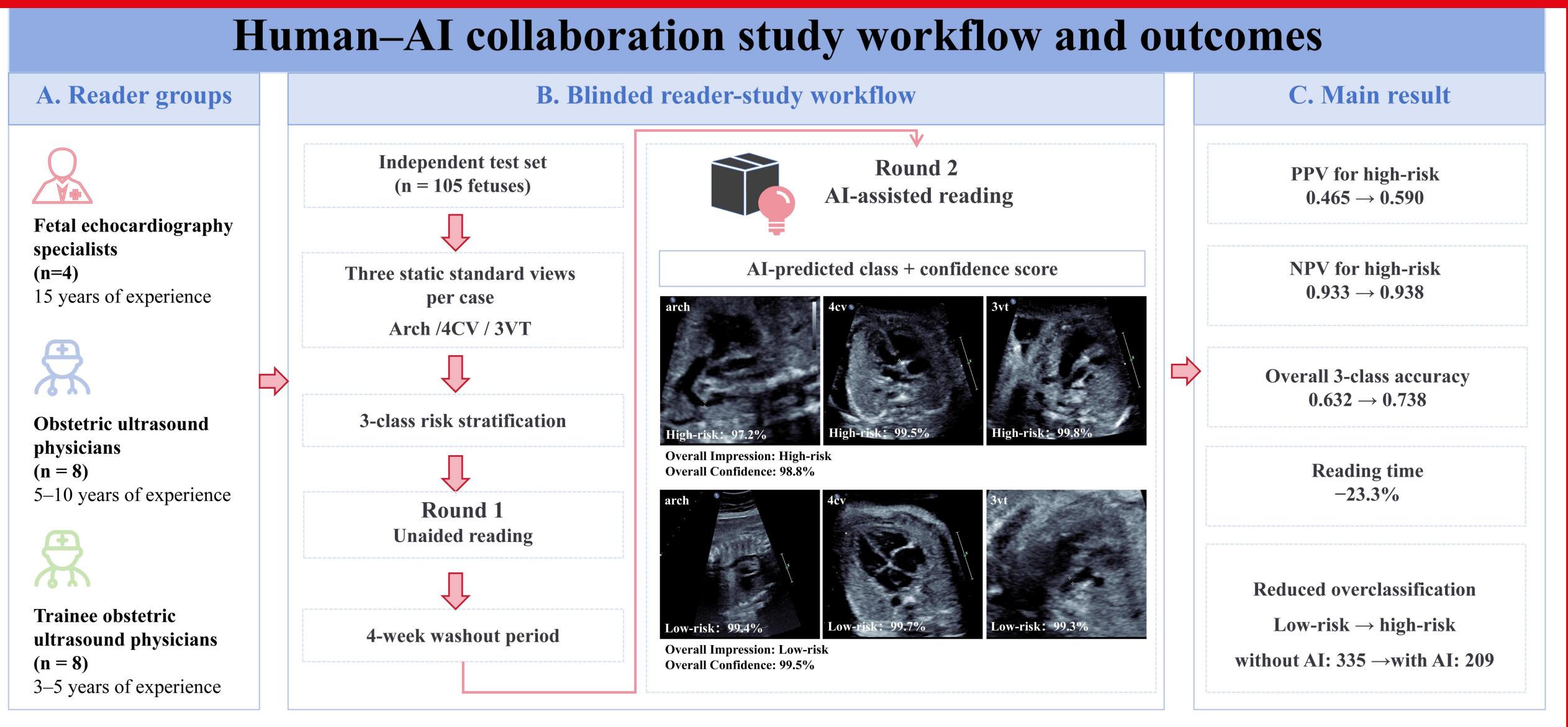


Figure 2. Human-AI reader study workflow and main outcomes

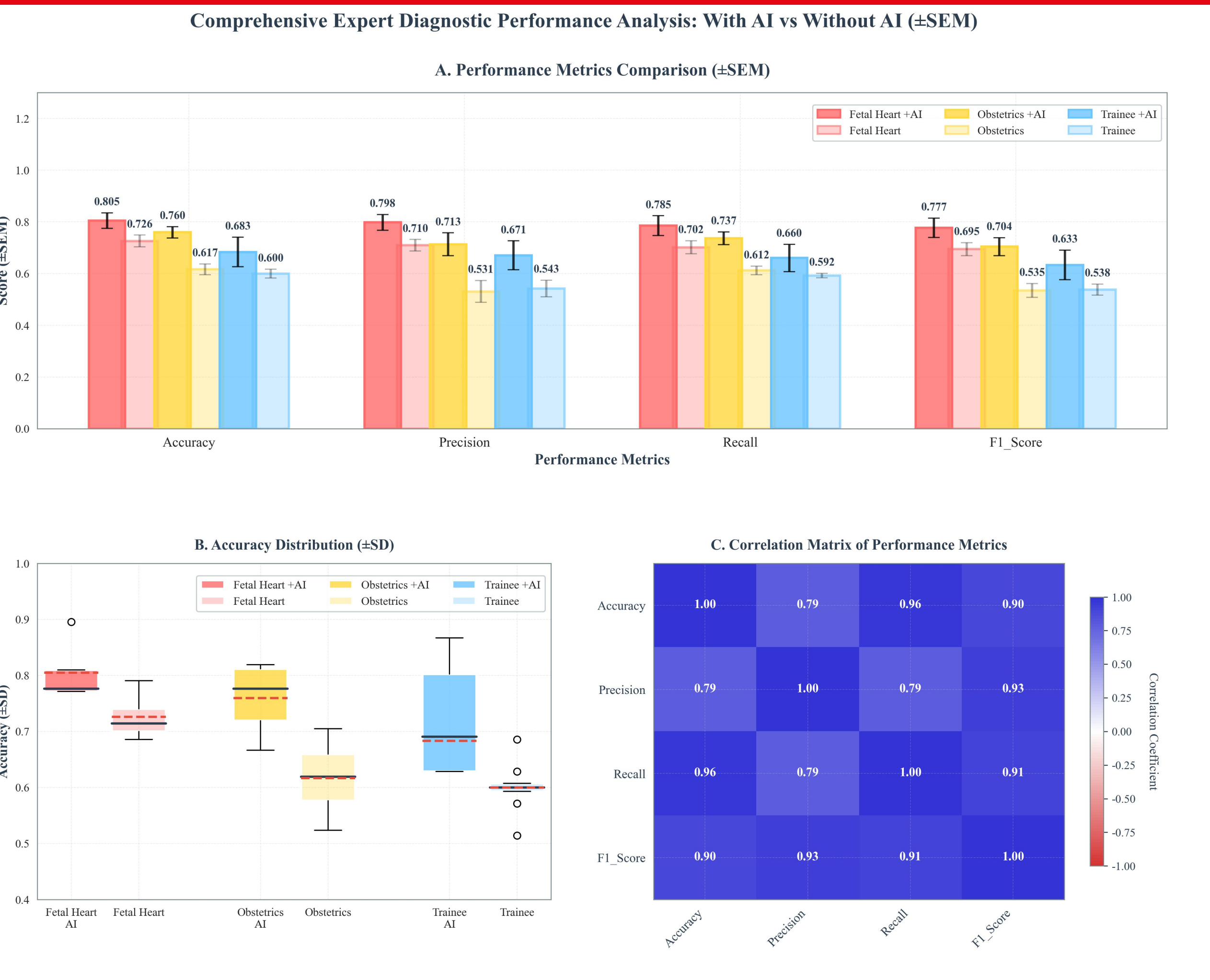


Figure 3. Comparison of overall diagnostic performance for prenatal risk stratification of suspected fetal CoA across physician experience levels, with and without AI assistance.