Appendix 1 Combined-model equations for malignancy prediction

In developing the combined model for predicting the malignant risk of breast lesions, we employed a logistic regression (LR) meta-model constructed on the predicted malignant probabilities from multiple base models, including clinical ultrasound (US), radiomics-habitat (Rad-Habitat), and deep learning (DL) models. LR uses the log-odds (logit) transformation to map a probability p to a linear predictor:

$$logit(p) = ln\left(\frac{p}{1-p}\right) = \eta = \beta_0 + \sum_{i=1}^{n} \beta_i X_i$$

where β_0 is the intercept, β_i are regression coefficients, and X_i denote the input features. In this study, each X_i corresponds to the malignant-class predicted probability (range 0–1) output by a base model. The final malignancy probability was obtained using the inverse-logit (sigmoid) function:

$$p = \frac{1}{1 + exp(-\eta)}$$

Combined (ABVS): the Combined (ABVS) model was constructed using the malignant-class predicted probabilities from the US (ABVS), Rad-Habitat (ABVS), and DL-two-and-a-half dimensional (2.5D) models. The LR meta-model was fitted on the training cohort, and the fitted coefficients were then fixed and applied unchanged to the internal validation and external test cohorts. The resulting equation is:

$$logit(p) = -6.568327 + 4.060200 \times P_{US\ (ABVS)} + 5.167485 \times P_{Rad\text{-}Habitat\ (ABVS)} + 4.937952 \times P_{DL\text{-}2.5D}$$

Combined (ABVS + SE): the Combined (ABVS + SE) model was constructed using the malignant-class predicted probabilities from the US (ABVS + SE), Rad-Habitat (ABVS), Rad-Habitat (SE), DL-2.5D, and DL-2D models. The LR meta-model was fitted on the training cohort, and the fitted coefficients were then fixed and applied unchanged to the internal validation cohort. The resulting equation is:

$$logit(p) = -7.594394 + 3.469675 \times P_{US\ (ABVS+SE)} + 3.337097 \times P_{Rad\text{-}Habitat\ (ABVS)} + 4.017836 \times P_{Rad\text{-}Habitat\ (SE)} + 3.603138 \times P_{DL\text{-}2.5D} + 2.125681 \times P_{DL\text{-}2D}$$

https://dx.doi.org/10.21037/qims-2025-1-2812