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Machine Learning Prediction of Anxiety Symptoms in Pregnant Women Based on Pregnancy-Specific Stress, Social Support, and Health Literacy

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1. Round 1

1.1. Reviewer 1

Reviewer:

In the final paragraph of the Introduction, the statement *"relatively few studies have simultaneously examined pregnancy-specific stress, social support, and health literacy as integrated predictors of anxiety symptoms using machine learning methodologies"* requires stronger support. The authors should provide a more systematic review of previous machine-learning studies in maternal mental health and clearly identify the specific research gap addressed by the present study.

In the Methods section, the sentence *"The final sample included 384 pregnant women from Tehran, who were selected through multistage convenience sampling"* requires further clarification. The authors should explain exactly how many prenatal centers were included, how participants were distributed across districts, and how recruitment procedures were implemented to reduce selection bias.

The inclusion and exclusion criteria described in the paragraph beginning with *"The inclusion criteria were being pregnant at the time of data collection"* are insufficiently detailed. Important factors such as diagnosed psychiatric disorders, psychotropic medication use, high-risk pregnancy status, or previous anxiety diagnoses should be addressed because they may substantially affect anxiety outcomes.

In the Measures section, the paragraph describing the Beck Anxiety Inventory states that participants were categorized according to *"the presence or absence of clinically meaningful anxiety symptoms."* The manuscript should specify the exact cutoff score used to dichotomize anxiety, provide a citation supporting this threshold, and justify its appropriateness for pregnant populations.

The paragraph describing the pregnancy-specific stress questionnaire lacks essential psychometric information. The authors should report the questionnaire's original developers, number of items, factor structure, scoring procedure, validity evidence, and reliability coefficients obtained in the current sample. Similar information should also be reported for all other instruments.

The feature-importance analysis reported in Table 3 requires methodological clarification. The manuscript does not specify whether importance scores were derived from gain, split frequency, SHAP values, permutation importance, or another method. Because different methods may yield different rankings, the authors should clearly identify the approach used and justify its selection.

In the Discussion section, the paragraph beginning with *"The machine learning findings represent another notable contribution of the study"* attributes superior model performance to nonlinear relationships among variables. However, no direct analysis of nonlinear effects is presented. The authors should either provide evidence supporting this interpretation or moderate the strength of the claim.

The manuscript does not sufficiently address external validity. Because all participants were recruited from Tehran and all measures were self-reported, the Discussion should more explicitly consider limitations regarding geographic generalizability, cultural specificity, and applicability of the prediction model to other populations of pregnant women.

Authors revised the manuscript and uploaded the document.

1.2. Reviewer 2

Reviewer:

In the section describing the Multidimensional Scale of Perceived Social Support, the authors state that both total and subscale scores were considered predictors. However, the final feature-importance table presents only a global social-support variable. The manuscript should clarify whether subscales were entered separately or aggregated into a single composite score during model development.

The paragraph describing the Health Literacy for Iranian Adults questionnaire should include more precise information about how the multidimensional structure of the instrument was handled analytically. It remains unclear whether individual domains were entered into machine-learning models separately or whether only the total score was used.

In the Data Analysis section, the statement *"Cases with substantial missing data were removed, while minor missing values were handled using appropriate imputation methods"* lacks sufficient detail. The manuscript should specify the percentage of missing data, the criteria used for case deletion, the imputation method employed, and whether sensitivity analyses were conducted.

The sentence *"The dataset was randomly divided into training and testing subsets, with 70% of the data allocated to model training and 30% allocated to model testing"* raises concerns regarding sample size adequacy for machine-learning applications. The authors should justify why a sample of 384 participants was sufficient for training seven algorithms and discuss potential risks of model instability and overfitting.

The paragraph describing model development mentions *"stratified k-fold cross-validation."* However, the manuscript does not specify the value of k. The authors should report the number of folds used, the rationale for selecting this configuration, and whether nested cross-validation was employed during hyperparameter optimization.

The statement *"Hyperparameter tuning was performed using cross-validation in the training dataset"* is overly vague. Reproducibility would be greatly improved by providing a detailed description of the tuning procedure, search strategy (grid search, random search, Bayesian optimization), parameter ranges tested, and final selected hyperparameters for each algorithm.

Table 1 reports strong correlations among predictors and anxiety symptoms. Given the substantial association between pregnancy-specific stress and social support (r = -.49), as well as between stress and health literacy (r = -.38), the authors should

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evaluate potential multicollinearity and discuss whether correlated predictors influenced model performance or feature-importance estimates.

The paragraph following Table 1 interprets anxiety symptom severity levels but does not provide confidence intervals or distributional information. Reporting skewness, kurtosis, or density plots would help readers assess whether the outcome variable exhibited class imbalance or unusual distributions that could affect machine-learning performance.

Table 2 presents highly favorable classification metrics, particularly for XGBoost (Accuracy = 93%, AUC = 0.97). These results appear unusually strong for psychosocial prediction models based on self-report data alone. The authors should provide calibration statistics, confusion matrices, and additional validation evidence to demonstrate that the model performance is not inflated.

The ROC curve presented in Figure 1 is visually informative, but the manuscript does not report confidence intervals for AUC values. Including 95% confidence intervals and statistical comparisons between competing models would strengthen the evidence supporting the superiority of XGBoost.

Authors revised the manuscript and uploaded the document.

2. Revised

Editor's decision: Accepted.
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