Prediction of Postpartum Depression Based on Social Support Indicators: A Machine Learning Approach

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Background

- Approximately **10 - 22%** of women suffer from Postpartum Depression (PPD)[1].
- PPD significantly affects maternal and infant well-being, with **unequal outcomes** stemming from disparities in social support.
- **Social and family support** plays a protective role, but **early detection** of PPD remains a challenge in clinical settings.
- Along with the development of **electronic healthcare record systems** and the increase of utilizing data-driven approaches in medical research[2], **machine learning (ML) approaches** are capable of performing accurate predictions in advance using data on health and social support records.

Study Question and Hypothesis

In this study, we propose a solution to use ML models to solve the research problem: **which social supportive factors can contribute to predict the occurrence of PPD, and what ML model has the best performance on such prediction**. Our contribution of this study includes:

(1) Examining relationships between social support factors and PPD using data-driven approaches.
(2) Building multiple ML models to perform PPD prediction.
(3) Evaluating prediction results using different metrics involving multiple predictive perspectives.

Methods

- **Data**
  PRAMS PHASE 8 (2016–2021), a large-scale survey dataset on maternal and infant health across U.S. states. Over 200,000 observations were analyzed.
- **Key predictors**
  social support, socioeconomic status, mental health history, and community resource access.

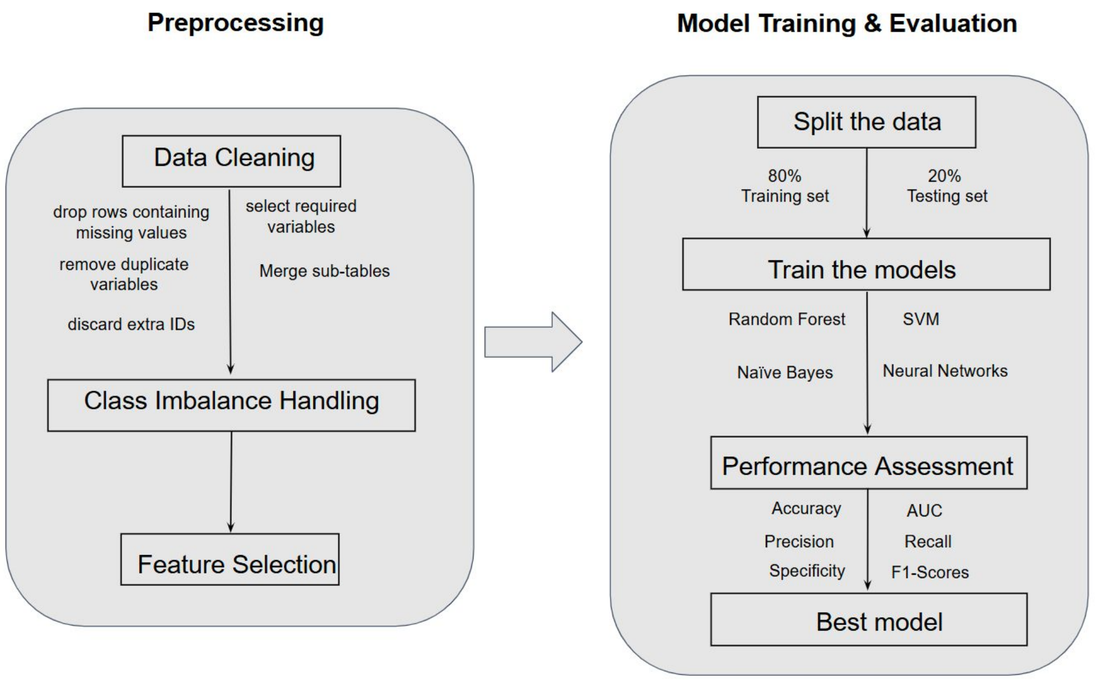

Figure 1. Data analysis procedure on predicting PPD.

Results

- **Most important features**: military insurance coverage, lack of postpartum health insurance, and abuse during pregnancy by a partner.
- A three-layers **Deep Neural Networks (DNN)** achieved the highest predictive accuracy (0.8052 on selected features; 0.8917 on full model).
- **DNN**s also achieved the highest AUC (0.9222) and F1-score (0.8849) in the full model
- Random Forest models performed well particularly in **precision** (0.9500) and **specificity** (0.9583).
- Naïve Bayes showed **high specificity** (0.9917) but had **low recall** (0.0417), limiting its ability to detect PPD cases.

Impact

- Early intervention and personalized mental health strategies will be allowed.
- Such integration offers healthcare professionals real-time risk assessments for PPD.

Table 1: 10 Most Important Features from LASSO

Variable	Description	Importance
HI_MILIT	Military insurance	1.7604
PP_NONE	No postpartum health insurance	1.7278
PAD6HUS	Abuse during pregnancy (partner)	1.1061
PP_IHS	Postpartum Indian Health Service	0.6205
HTH_ANX	Anxiety history	0.5786
BPG_DEPRS8	Depression history	0.5668
BCB_HUSB	Partner didn't want baby	0.2912
PAT_ACK	Paternity acknowledgment	0.2112
INCOME8	Household income level	0.2009
PRE_MHDP	Pre-pregnancy depression	0.1913

Table 2: Model Performance Comparison on Selected and Full Feature Sets

Models	Random Forest	SVM	Naive Bayes	Neural Network	Deep NN
Selected Model					
Accuracy	0.7792	0.7042	0.5167	0.7333	**0.8042**
AUC	0.7792	0.7465	0.7107	0.7878	**0.8532**
Precision	0.8317	0.7333	0.8333	**0.8784**	0.8763
Recall	0.7000	0.6417	0.0417	0.5417	**0.7083**
Specificity	0.8583	0.7667	**0.9917**	0.9250	0.9000
F1-score	0.7601	0.6844	0.0794	0.6701	**0.7833**
Full Model					
Accuracy	0.8750	0.6750	0.6208	0.8417	**0.8917**
AUC	0.8750	0.7180	0.7034	0.8679	**0.9222**
Precision	**0.9500**	0.6875	0.7101	0.9362	0.9434
Recall	0.7917	0.6417	0.4083	0.7333	**0.8333**
Specificity	**0.9583**	0.7083	0.8333	0.9500	0.9500
F1-score	0.8636	0.6638	0.5184	0.8224	**0.8849**

Conclusions

- Social support from family and community, access to healthcare, and mental health history are **significant predictors** of PPD risk.
- **Insurance coverage** is crucial in influencing PPD outcomes.
- **Deep neural networks** show superior predictive ability for PPD classification across different perspectives.

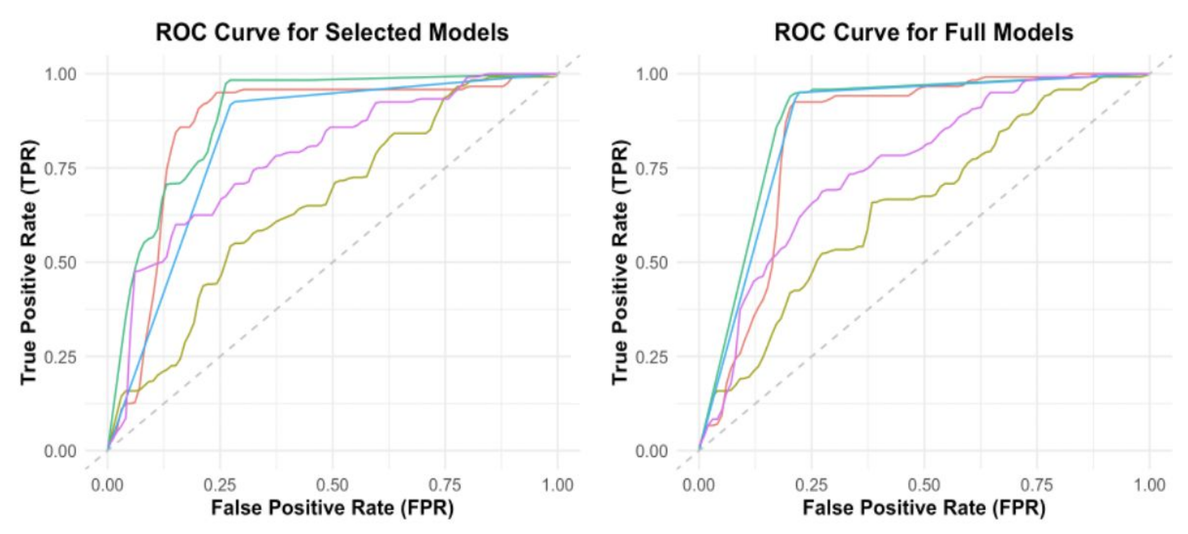

Figure 2. ROC Curve of all models

Limitations

- **Data Quality Issues:**
  Significant missing values in PRAMS data.
  Survey data conversion requires extensive pre-processing.
- **Modeling Challenges:**
  Correlated social factors challenge models assuming feature independence (e.g., Naïve Bayes).
- **Future Directions:**
  Explore advanced learning techniques and large language models to address data quality and structure issues.
  Incorporate decision-making theories to enhance recommendation performance.

Reference

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2. Zhang, Y., Wang, S., Hermann, A., Joly, R., & Pathak, J. (2021). Development and validation of a machine learning algorithm for predicting the risk of postpartum depression among pregnant women. Journal of affective disorders, 279, 1-8.
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