IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 2, May 2025
Impact Factor: 7.67

Machine Learning-Driven Analysis of Maternal Psychological Health Impacts on Infant Behavior and Sleep Quality

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Abstract: *Maternal psychological health during the postpartum period plays a critical role in shaping an infant's behavioral development and sleep quality. This study presents a machine learning-based approach to model and predict the relationship between maternal mental health indicators—such as depression, anxiety, and bonding—and infant temperament and sleep outcomes. A dataset comprising 410 mother-infant pairs was analyzed, incorporating psychometric scales like the Edinburgh Postnatal Depression Scale (EPDS), Hospital Anxiety and Depression Scale (HADS), and the Child Behavior Traits Scale (CBTS). The proposed methodology integrates Random Forest (RF) for feature selection with a Multilayer Perceptron (MLP) for classification, forming a hybrid RF-MLP model that accurately categorizes infant behavior into quiet, moderate, or contradictory types. Additionally, Fuzzy C-Means clustering is employed to analyze sleep quality by grouping infants into soft-labeled clusters such as good, moderate, and poor sleep. This dual-model approach captures the nonlinear and uncertain nature of maternal-infant interactions more effectively than conventional linear classifiers. Evaluation metrics including accuracy, precision, recall, F1-score, and silhouette score confirm the model's high performance and reliability. The results reveal strong correlations between elevated maternal depression or anxiety scores and undesirable infant behavioral traits, along with disturbed sleep patterns. This framework provides practical utility for clinical decision support, telehealth applications, and early psychological intervention. The study emphasizes the potential of machine learning in advancing personalized maternal and infant care through data-driven insights.*

Keywords: Maternal Health, Infant Behavior, Postpartum Depression, Random Forest, Multilayer Perceptron, Fuzzy C-Means Clustering, Sleep Quality, Machine Learning, EPDS, HADS, Child Bonding

DOI: 10.48175/IJARSCT-26238