Design and Development of an AI-based Web Application for Early Detection of Postpartum Depression In Sri Lanka

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***Abstract*— Postpartum Depression (PPD) is a significant mental health issue that affects a considerable number of new mothers globally. This project designs, develops, and pilots a new AI-based web tool called 'PPDAI' to fill a significant gap in postpartum mental healthcare in Sri Lanka. Postpartum Depression (PPD) is a significant mental health issue that affects a considerable number of new mothers globally. Despite its frequency, awareness and treatment options Beyond simply digitizing existing scales, like the EPDS, the system is unique in that it incorporates a CatBoost machine learning model for risk prediction trained on culturally appropriate indices. In a pilot deployment, preliminary results indicated that more than 10% of users were classified as high risk, indicating a high prevalence of unmet mental health needs and reinforcing the need for accessible, stigma-free treatment options. This research showcases the potential of AI to help fill access gaps in healthcare by using technology-based platforms to scale up early postpartum depression diagnosis in low-resource settings.**

Keywords: postpartum depression, mental health, web application, Sri Lanka, early detection

I. INTRODUCTION

Mothers may have postpartum depression (PPD), a significant mood illness, following childbirth. It consists of unrelenting sadness, anxiety, and even mental and emotional detachment from the child. PPD lasts for a longer time, and is more detrimental, than the fleeting "baby blues" that are gone two weeks after giving birth. It can impose mental and physical consequences on both mother and child for multiple months, or even years, if not dealt with properly. New mothers are certainly not alone. Approximately 10-20% of women on a global scale suffer from this condition, which is a troubling reality many countries seem to ignore and is a means of damaging the family unit, child development, and health as a society as a whole. It touches on many facets of public health and has consequences which last for generations.

The issue of mental health after childbirth is of prime concern, yet it is consistently neglected. Post physical maternity care has seen some improvement in Sri Lanka, but the mental health care system is completely obsolete. It is even more alarming that the stigma that surrounds mental health issues worsens the situation. Many mothers suffer from postpartum depression, yet after childbirth they treat themselves with the utmost contempt, and numerous times attribute their condition to normal post birth "baby blues." Because of this, they prefer to remain silent and not voice their emotional struggles for fear of negative social perception. This barrier, which many women find themselves behind, has severe consequences, and delays the help they desperately need.

Access to care is complicated and systemic in nature. There are insufficient mental health professionals who are adequately trained, and there is overall a concentration of services in urban areas, contributing to a significant access gap for moms living in rural and low-income environments. [12]. Even when services are accessible, lengthy travel distances, related expenses, and time constraints are significant barriers for new moms [1]. Furthermore, existing screening instruments, such as the Edinburgh Postnatal Depression Scale (EPDS), have been validated in Sri Lanka [15], but they are mostly paper-based and delivered inconsistently, mostly in clinical settings. This makes them unavailable to a substantial proportion of the postpartum population, who may not have regular interaction with the healthcare system following birth [4, 7].

Research on PPD in Sri Lanka is still in its early phases, however new research shows an alarming prevalence rate. Wickramaratne et al. (2019) discovered a considerable burden of PPD symptoms, highlighting the silent epidemic [4]. Similarly, Samarasekara et al. (2022) revealed multiple prenatal risk factors, emphasizing the importance of targeted screening [12]. However, there is a significant disparity in the availability of culturally appropriate, scalable, and accessible intervention techniques that can bridge the gap between moms in need and the help they seek.

Digital health technologies offer a viable way to overcome structural and socio-cultural constraints. Web and mobile applications can provide anonymous, adaptable, and real-time support, reducing the fear of stigma and geographical limitations [7-9]. Globally, AI-powered systems have shown effective in detecting depression severity and providing personalized feedback [13]. However, its use in South Asia, particularly in Sri Lanka, is uncommon. Most existing solutions are not

tailored to the local cultural context or the technological realities of a mobile-first, frequently low-bandwidth user base [9].

This work proposes to solve this essential gap by designing and developing "PPDAI," an AI-based, culturally sensitive web tool for the early diagnosis and management of PPD in Sri Lanka. This study is guided by the following questions

1. How can a machine learning model (Cat Boost) train on a culturally specific multidimensional questionnaire improve the accuracy of early PPD risk stratification in Sri Lankan's mothers?

2. How much can digital, anonymous support lower perceived stigma and increase participation in mental health services among postpartum mothers?

3. How does the mix of instant, AI-driven feedback and tailored coaching affect the user experience and potential mental health outcomes?

The suggested system seeks to provide a private, accessible, and scalable first line of defense against PPD by combining a powerful AI-driven risk prediction engine with culturally relevant educational information and a helpful chatbot (Support AI). This paper describes the development process, offers results from pilot research, and explores the digital framework's potential to transform postpartum mental healthcare service in Sri Lanka and other low-resource settings.

II. LITERATURE REVIEW

While digital health technologies hold promises for delivering flexible and anonymous mental health care globally [7, 9], their immediate relevance to the Sri Lankan context is severely constrained. A fundamental shortcoming is a lack of strong cultural assimilation. Several established approaches depend upon surface level linguistic translation, without engaging with the ideas behind the conceptualization of mental health.

Western definitions of depression, for instance tend to emphasize individualistic symptoms such as guilt, even if this does not capture the somatization of distress (e.g., as " heaviness of head" and fatigue), or better captures family and social expressions of suffering that are commonplace in collectivist cultures such as Sri Lanka (and also in western collective spaces) [16, 8]. A lack of cultural validity increases the risk of misidentification and decreases engagement among users.

Also, there is a significant shortfall in developing AI models based on relevant local data to demonstrate predictive validity. Most applications are static sources of information or AI algorithms that have been developed and validated in western populations. Using such models in a different cultural setting can result in biassed and inaccurate risk estimates because the symptomatology and risk variables for PPD can differ dramatically [12, 4]. The work of scholars such as Rowel et al. [15], who validated a Sinhala version of the EPDS, demonstrates the importance of local calibration for even standard tools. Also, there is a significant shortfall in developing AI models based on relevant local data to demonstrate predictive validity. Most applications are static sources of information or AI algorithms that have been developed and validated in western populations.

III. METHODOLOGY

This research occurs within a mixed-methods framework, meaning both qualitative and quantitative techniques are employed so that an explicit comprehension of postpartum depression (PPD) as well as the usability of the proposed web application can be obtained. The main target population for the study consists of postpartum mothers from urban and rural populations, mental health professionals (psychologists, psychiatrists), technology professionals, and maternal health policymakers.

Data collection will consist of methods. Structured surveys will yield quantitative data on PPD awareness, prevalence, and user needs. Expert opinions about PPD diagnosis and treatment will come in the form of semi-structured interviews with healthcare professionals. Discussions in focus groups with mothers will provide feedback regarding the usability, accessibility, and cultural relevance of various application features. [5]

Additionally, literature, health policies, and established screening tools will be reviewed to confirm clinical accuracy and cultural appropriateness. The survey data will be analyzed with descriptive statistics and reveal important trends and patterns. Interview and focus group data will be thematically analyzed to discover shared concepts and user perspectives. [6] The application will also utilize AI-based predictive analysis of users' self-assessment responses to identify risk levels.

The engagement data (session time, feature use, and frequency of feedback) will be used to evaluate the effectiveness of the platform. The study model is formed on a few main hypotheses: using AI technologies for self-assessment tools can increase rates of early identification; [3] a culturally tailored and multilingual questionnaire for initial assessment can increase accuracy and accessibility; and digital access can reduce equity gaps in long-term adverse mental health effects among postpartum mothers.

This integration makes sure that the method is technically robust, socially appropriate, culturally grounded, and fit for addressing the complex challenges postpartum mothers encounter in Sri Lanka. [7]

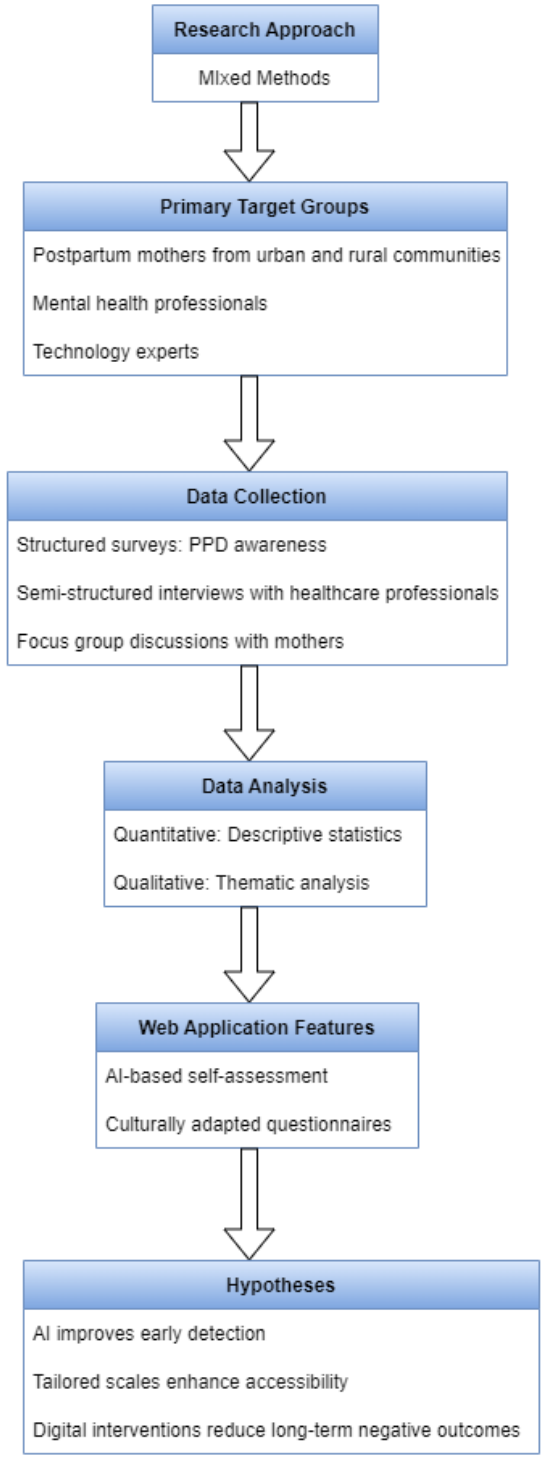


Fig. 1. Proposed System Architecture

IV. RESULTS AND DISCUSSION

A. SYSTEM INTERFACES AND MAIN FEATURES

PPDAI is a web application using a React frontend with FastAPI as a backend providing an intuitive and helpful experience for mothers evaluating and managing postpartum depression. [8]

Home & Information Interface – Includes educational content on postpartum depression, and "Baby Blues," and other related conditions, all presented in warm and soothing colors, clear typography, and straightforward navigation for ease of use and understanding, while also culturally relevant for mothers in Sri Lanka.

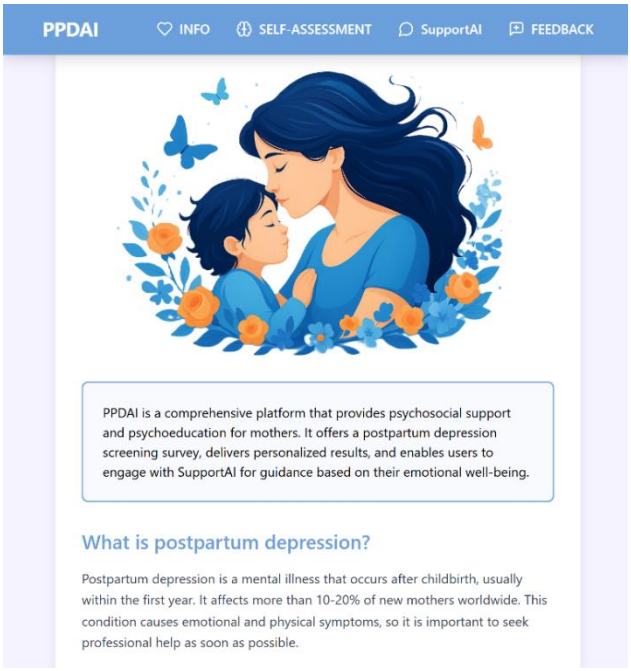


Fig. 2. Survey Interface

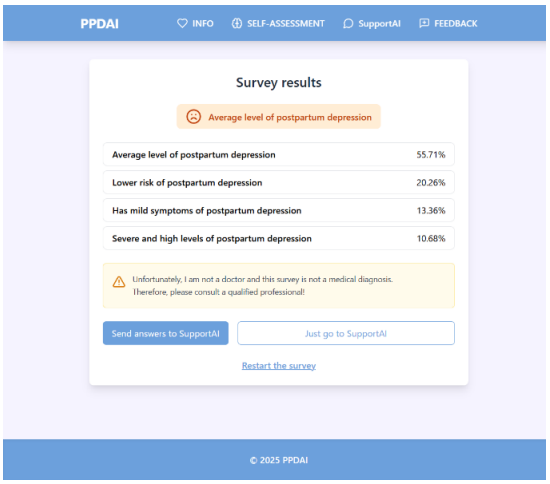


Fig. 3. Survey Results Interface

Survey Interface – The survey interface is a multi-step form designed for holistic PPD risk assessment. It is divided into five structured sections: Demographic Information, Psychic and Emotional State, Social and Family Support, Dealing with Stress, and General Additional Information. Survey Results Interface – Presents a concise breakdown of postpartum depression risk categories (e.g., lower risk 20.26%, mild symptoms 13.36%, average level 55.71%, severe level 10.68%) with a visually appealing design. It

includes a "Send answers to SupportAI" button for seamless chatbot integration and a prominent disclaimer urging professional. Consultation ChatBot Interface (SupportAI) – Offers real-time emotional support via an AI assistant with a simple chat layout, featuring a welcoming message and an input field for user queries, ensuring privacy and empathetic guidance. [13]

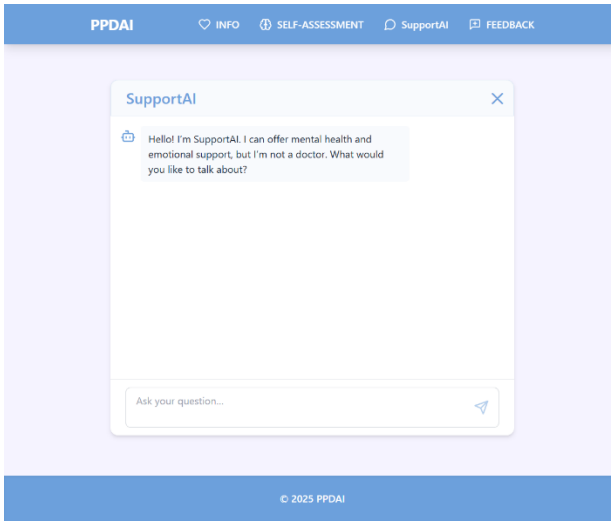


Fig. 4. Consultation ChatBot

B. Existing Application in screening Postpartum Depression

The application is expected to yield several positive outcomes. First, it will fill the diagnostic gap by providing an accessible screening tool. Second, Second, AI and predictive models can contribute to more trustworthy diagnoses. Third, the non–context-bound user-friendly design of the app and its multilingual support and anonymity will induce better participation from particularly underprivileged populations. Through the analysis of user data, researcher can also determine typical risk factors for more effective content delivery. [Perhaps the platform could also act as a research repository (for ongoing maternal mental health studies). User input will be vital to an iterative development process, which will keep the tool current and culturally appropriate.

C. Features of the Proposed System

The PPDAI will be a comprehensive, culturally inclusive web application for PPD screening and referral. The app will consist of a modern React.js frontend and a FastAPI powered backend, ensuring a responsive, hi-fidelity, scalable user experience across devices. Key features include:

Culturally-Tailored Educational Content: A separate user interface for educational content that follows a mild but soothing design and placates the user with related knowledge on PPD, “Baby Blues,” and other similar conditions. Likewise, language and tone are adapted to foster cultural relevancy situated in Sri Lanka.

Comprehensive Multi-Dimensional Assessment: The application includes a detailed and multi-step questionnaire divided into five essential domains: Home Demographics, Psychological and Emotional Condition, Social and Family Supports, Coping with Stress, and General Other Information. This comprehensive strategy ensures risk assessment includes biological, psychological, and social determinants of health. Machine Learning Risk Prediction: The application employs a CatBoost classification model at its core; gradient boosting model optimized for use with categorical survey data. The model uses user responses to classify the user as Low, Mild, Moderate, or High risk for prenatal and postpartum depression. The risk assessment will provide immediate and data-informed risk classification. Integrated Chatbot Support (SupportAI): In order to connect assessment and intervention, application offers an AI powered chatbot. This feature provides real time, empathetic, and stigma free emotional support and guidance, motivating users to engage with the platform in an engaging way. Visualized Feedback and Reporting: The results interface provides a straightforward, visual overall summary of the users risk category for PPD, presented with percentages, making the results easy to process. A strong disclaimer is clearly present that users should seek appropriate professional care for high risk cases. Community Feedback System: A user-generated feedback component allows app users to rate their experience, and share their experiences - anonymously, if they choose. The feedback system creates community, and provides valuable qualitative data for iterative improvement of the platform. Privacy-Focused and Accessible Design: The application is entirely designed with anonymity as a default bias, removing at all levels, any fear of stigma. Embedded in a mobile-reponsive environment will allow the application to function on any sized device - necessary considering areas where populations are limited to cell phone access and not computers, including desktop computers.

D. Discussion of results

The pilot survey results identified a distribution of PPD risk levels for users as follows: 20.26% low risk, 13.36% mild, 55.71% moderate, and 10.68% severe. These results indicate high levels of subclinical and moderate symptom severity, which aligns with prior studies that indicate global incidence rates of between 10-20%. Importantly, it is noted that one in every ten mothers would be classified as being at severe risk level, which may call for intervention for mothers who seek further care. Lastly, participants reported positive user experiences, and described attributes of ease, privacy, and appropriateness based on their cultural experiences with the support app. Engagement improved with SupportAI, and continued to support the studies indicating increasing motivation and decreasing symptoms due to the AI chatbot. Digital screening also reduced barriers of stigma and access in rural communities. The findings reiterate that PPDAI is a dual-purpose resource that is both a valid clinical screening tool and adjunctive

mental health program. Future evaluations should explore ongoing engagement, referrals for further treatment, and clinical outcomes.

E. *Mathematical Model and Formulas Used*

The predictive element within the PPDAI application is generated using a CatBoost classification model—a gradient boosting model effective for categorical and ordinal data.

1. Data Preprocessing**:** Survey responses are first transformed into numerical representations. *One-hot encoding* is applied to multi-select questions, *ordinal encoding* is used for ranked frequency scales (e.g., "Never" to "All the time"), and nominal categories are label-encoded. This step ensures that the model interprets user input correctly while preserving the order of severity where appropriate.

2. Model Training: CatBoost constructs an ensemble of decision trees sequentially, where each tree improves on the residual errors of the previous ones. For a dataset (xi,yi), the model learns a mapping F(x) by minimizing the multi-class cross-entropy loss:

$$L = -\sum_{i=1}^{N}\sum_{k=1}^{K} y_{i,k} \log p_{i,k}$$

where y i,k is the true class label and p i,k is the predicted probability for class k.

3. Prediction: Probabilities are obtained using the softmax function:

$$p_{i,k} = \frac{e^{f_k(x_i)}}{\sum_{j=1}^{K} e^{f_j(x_i)}}$$

This ensures all class probabilities sum to 1. The model then assigns each user to one of four risk categories Low, Mild, Moderate, or Severe and presents results as percentages.

4. Advantages: By utilizing ordered boosting, CatBoost mitigates overfitting and avoids target leakage when dealing with categorical features. This yields accurate, interpretable, and clinically meaningful predictions for postpartum depression risk assessment.

V. CONCLUSION

The suggested website application (PPDAI) has significant potential as a useful early detection and intervention tool for postpartum depression (PPD) in Sri Lanka. Pilot survey results show that 20.26% of participants reported being at low risk, 13.36% at mild risk, 55.71% were at moderate risk, and 10.68% were identified at severe risk for PPD. These findings demonstrate an overall high level of moderate-severe symptoms in mothers and further highlight the importance of providing easily accessible digital interventions. Usability evaluations confirmed the web app is culturally acceptable, private, and user-friendly, and the integrated SupportAI chatbot offered real-time guidance, improved engagement and lowered the stigma of accessing support.

The web app system combined AI-driven risk identification, structural self-reflection, and culturally relevant education proactively overcame barriers of access to to awareness, stigma and access, and therapists. The web app is not only a valid screening tool, but also a supportive platform that cross-validate the traditional health service.

Looking ahead, there are a number of improvements recommended for the next phase of development. The most important recommendation for future development is to create a connection to Sri Lanka's healthcare system so that high risk mothers can be connected to professional counseling and psychiatric services directly within the system. Developing a companion mobile application would also allow greater audience access of the system, especially for mothers who may have limited access to healthcare services in rural areas. Furthermore, evaluating the PPDAI system for long-term period of time, will help improve on how to assess user retention, referral uptake and clinical outcomes.

The system could be further improved by including multilingual support to have more local languages, increasing inclusivity among communities that may be more diverse. Other potential future improvements to the basic AI models would be to add larger datasets and analyze the chatbot conversations of mothers for sentiment. In addition, community-based features (e.g., peer-support forums, moderated discussion groups) could provide a source of social support for new mothers and work towards addressing isolation issues.

In conclusion, the PPDAI system has shown to produce positive results towards addressing postpartum mental health and support issues to support mothers in Sri Lanka. Building on further iterations of the PPDAI, accessibility through integration with the healthcare service, it has the potential to be scalable, sustainable and impactful digital health solution for mothers' wellbeing.

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