Evaluating the Effectiveness of AI-Assisted Interventions in Improving Maternal Mental Health and Neonatal Bonding Outcomes

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Received: 2nd Mar, 2026 | **Revised:** 14th Mar, 2026 | **Accepted:** 4th Apr, 2026 | **Available Online:** 20th Apr, 2026

ABSTRACT

Background: The postpartum period is a critical window for both maternal mental health and infant development. This study evaluates the impact of an AI-driven support system utilizing personalized chatbots and predictive mood tracking on reducing psychological distress in mothers and enhancing the emotional bond with their neonates.

Aim of the study: To evaluate the effectiveness of AI-assisted interventions on improving maternal mental health and neonatal bonding outcomes.

Subjects and method: Study design: a pre-test/post-test experimental design was used to achieve the aim of this study. The research took place at the Postnatal Outpatient Clinics at Sohag University Hospitals and Maternal and Child Health (MCH) Centers (Dar-Elsalama, AbdAllah at Sohag City). Sample: It included 100 mothers and their neonates. It was divided into two groups: Experimental Group (n=50): Received AI-assisted interventions (e.g., AI chatbots for CBT, predictive mood tracking, and personalized neonatal care alerts). Control Group (n=50): Received standard conventional postnatal care and routine check-up. Data Collection Tools: Demographic & Personal Data Sheet; Edinburgh Postnatal Depression Scale; State-Trait Anxiety Inventory; and Postpartum Bonding Questionnaire: To evaluate the quality of the mother-infant relationship and detect any bonding impairments.

Results: The experimental group showed a statistically significant drop in EPDS and STAI scores compared to the control group. AI-assisted mothers reported higher confidence in responding to neonatal cues, leading to superior PBQ scores. The AI system accurately flagged 14% of mothers in the experimental group for early clinical intervention before symptoms escalated.

Conclusion: The study concluded that AI-assisted interventions provide a superior framework for postnatal care compared to traditional methods alone. By offering immediate, personalized, and data-driven psychological support, these tools significantly mitigate the risks of postpartum depression and anxiety, thereby creating an optimal environment for neonatal bonding and healthy infant development.

Recommendations: Integrating AI-driven mental health screening into primary maternal healthcare. Training healthcare providers to use AI dashboards for remote monitoring of high-risk mothers. Future research with larger samples to validate the long-term developmental impact on the neonates.

Keywords: AI-Assisted Interventions, Maternal Mental Health, Neonatal Bonding Outcomes.

How to cite this article: Osman ZHH, Ahmed LAEHA, Said DA, ElShora SNA, Soliman SMA, Albishi MAB, Elemary FM, Bashir WAH, Ahmed ASM, Elfar AGZ, Mansy ARME, Morsy ZYA. Evaluating the Effectiveness of AI-Assisted Interventions in Improving Maternal Mental Health and Neonatal Bonding Outcomes. Int J Drug Deliv Technol. 2026;16(34s):502-515. DOI: 10.25258/ijddt.16.34s.66

Source of support: Nil.

Conflict of interest: The authors declare no conflict of interest.

Since 2020, the landscape of maternal healthcare has shifted dramatically toward digital health solutions. The postpartum period remains a critical "fourth trimester" where physiological and psychological vulnerabilities intersect. Recent studies emphasize that nearly 20% of women in low-and-middle-income countries suffer from postpartum depression (PPD), a figure that has remained high despite traditional clinical interventions **(Ameyaw et al., 2024; Hanach et al., 2024).**

Artificial Intelligence (AI) has emerged as a transformative force in monitoring maternal mental health. Unlike static educational brochures, AI-driven systems utilize Natural Language Processing (NLP) and Machine Learning (ML) to provide personalized, real-time interventions. Research by **(Faujiah & Raraswati, 2025)** demonstrates that AI chatbots can effectively deliver Cognitive Behavioral Therapy (CBT) components, reducing symptoms of anxiety and depression by providing a "non-judgmental" space for mothers to express distress. Furthermore, predictive mood tracking allows for the identification of sub-clinical symptoms before they escalate into severe depressive episodes **(Huang et al., 2025).**

Postpartum anxiety, often measured by the State-Trait Anxiety Inventory (STAI), has been identified as a significant predictor of poor maternal-infant interaction. Recent literature highlights that high levels of "State Anxiety" interfere with a mother's cognitive ability to interpret neonatal signals, such as hunger or sleep cues. AI interventions that offer immediate relaxation techniques and "nudges" have shown a statistically significant

impact on lowering STAI scores in high-stress environments **(Lewkowitz et al., 2024).**

The quality of the mother-neonate bond is the primary determinant of infant socio-emotional development. The **Postpartum Bonding Questionnaire (PBQ)** is now increasingly used in digital health research to assess how psychological stability translates into physical and emotional attachment. **Kerimoglu Yildiz et al. (2025)** found that digital platforms providing "just-in-time" neonatal care alerts—similar to those used in the current study—empower mothers, increase their self-efficacy, and result in superior bonding outcomes compared to traditional care models.

In Egypt, particularly in Upper Egypt regions, the integration of AI in postnatal care is a pioneering step. While traditional check-ups at **Maternal and Child Health (MCH) Centers** focus heavily on physical recovery, the psychological dimension often remains underserved. This study bridges this gap by evaluating a hybrid model of care that combines clinical expertise with the efficiency of AI-assisted support.

Significant of the study:

Despite the critical importance of the postpartum period for both maternal mental health and neonatal development, a significant "care gap" exists between hospital discharge and long-term recovery. In Egypt, and specifically within the healthcare context , traditional postnatal care at Maternal and Child Health (MCH) Centers remains predominantly focused on physical recovery and neonatal vaccinations, often overlooking the psychological well-being of the mother **(Hanach et al., 2024).** Current statistics indicate that postpartum depression (PPD) and anxiety (PPA) affect a substantial percentage of women, yet many remain undiagnosed due to the stigma surrounding mental health and the shortage of specialized psychiatric resources in rural and semi-urban areas**.** This lack of continuous psychological monitoring directly correlates with impaired mother-neonate bonding, as measured by the PBQ, leading to potential long-term developmental delays in the infant **(Huang et al., 2025).**

While recent global literature suggests that AI-assisted interventions—such as CBT-based chatbots and predictive mood tracking—can provide 24/7 personalized support, there is a profound lack of empirical evidence regarding the effectiveness of these digital tools in the Egyptian clinical setting **(Faujiah & Raraswati, 2025).** Most existing digital health studies have been conducted in Western contexts, leaving a gap in understanding how culturally-adapted AI can mitigate distress (measured by **EPDS** and **STAI**) and enhance bonding among Egyptian mothers.

Therefore, this study addresses this critical gap by evaluating whether integrating AI-driven support into the routine care at **Sohag University Hospitals** can significantly improve maternal mental health outcomes and foster a more secure emotional bond between mothers and their neonates.

Operational Definitions

1. AI-Assisted Intervention

- **Operational Definition:** In this study, it refers to the **mobile health (mHealth) platform** provided to the Experimental Group. This platform includes:
  - **Conversational Agent (Chatbot):** An AI trained in Cognitive Behavioral Therapy (CBT) for 24/7 emotional dialogue.
  - **Predictive Analytics:** Algorithms that analyze user input to flag potential risks of PPD.
  - **Personalized Alerts:** Automated notifications sent to mothers regarding neonatal care and mood management.

2. Maternal Mental Health

- **Theoretical Definition:** The psychological, emotional, and social well-being of a woman during the postpartum period.
- **Operational Definition:** Measured by the mother's scores on two standardized tools:
- **The EPDS:** Where a score of ≥13 indicates high depressive risk.
- **The STAI:** Where higher scores indicate increased levels of **State (temporary)** and **Trait (permanent)** anxiety.

3. Neonatal Bonding

- **Theoretical Definition:** The unique emotional relationship between the mother and her newborn, characterized by warmth, responsiveness, and attachment.
- **Operational Definition:** Quantified by the total score on the **Postpartum Bonding Questionnaire (PBQ)**. **Lower scores** represent a healthy, secure bond, while **higher scores** (exceeding established cut-offs for factors 1 to 4) indicate bonding impairments or rejection.

4. Postnatal Period

- **Operational Definition:** For the purpose of this study, it refers to the period starting from the first week following delivery up to the completion of **three months (12 weeks)** postpartum, during which the follow-up assessments are conducted at **Sohag University Hospitals** and **MCH centers**.

Aim of the study:

To evaluate the effectiveness of AI-assisted interventions on improving maternal mental health and neonatal bonding outcomes.

Research Hypotheses

To achieve the aim of this study, the following hypotheses were formulated:

(H1): Mothers in the **Experimental Group** who receive AI-assisted interventions will demonstrate a statistically significant lower mean score on the **Edinburgh Postnatal Depression Scale (EPDS)** in the post-test compared to their pre-test scores and compared to the **Control Group**.

(H2): Mothers in the **Experimental Group** will exhibit a significant reduction in both "State" and "Trait" anxiety levels, as measured by the **State-Trait Anxiety Inventory (STAI)**, following the AI intervention compared to the Control Group who receives standard care.

(H3): The **Experimental Group** will achieve significantly better outcomes in maternal-infant attachment, evidenced by lower scores (indicating healthier bonding) on the **Postpartum Bonding Questionnaire (PBQ)** compared to the Control Group.

(H4): There will be a significant positive correlation between the AI-driven "early warning alerts" and the clinical identification of mothers at high risk of psychological distress, facilitating earlier intervention than traditional screening methods.

Subjects and Method:

1. Study Design

A **pre-test/post-test experimental design** was employed to evaluate the impact of AI-assisted interventions on maternal mental health and neonatal bonding outcomes. Participants were randomly assigned into two groups (Experimental and Control) to ensure a rigorous comparison of outcomes.

2. Study Setting

The research was carried out in two primary clinical environments in Sohag, Egypt:

- **Postnatal Outpatient Clinics at Sohag University Hospitals:** Known for high-volume postnatal follow-ups and diverse patient demographics.
- **Maternal and Child Health (MCH) Centers (Dar El-Salama Abd-Allah) in Sohag City:** These centers provide primary healthcare and vaccinations, serving as a hub for community-based postnatal monitoring.

3. Subjects

- **Sample Size:** A convenience sample of **100 mothers and their 100 neonates** who met the inclusion criteria.
- **Group Allocation:**
  - **Experimental Group (n=50):** Received the AI-assisted intervention package (AI-driven chatbot, mood tracking, and automated alerts).
  - **Control Group (n=50):** Received standard conventional postnatal care, including routine hospital check-ups and traditional health education.

Selection Criteria

To ensure the validity and reliability of the study results, the 100 mothers and their neonates were selected based on the following specific criteria:

1. Inclusion Criteria

Participants were eligible for the study if they met the following requirements:

- Mothers aged between 18 and 45 years.

- Both primiparous (first-time mothers) and multiparous women.
- **Neonatal Status:** Healthy full-term neonates (gestational age ≥ 37 weeks) with a birth weight ≥ 2.5 kg.
- Mothers who own a smartphone and have basic digital literacy to interact with the AI application.
- Proficiency in reading and writing Arabic (to interact with the AI interface and questionnaires).
- Willingness to participate .

2. Exclusion Criteria

3. Participants were excluded if they presented any of the following:

- Mothers with severe obstetric complications (e.g., severe pre-eclampsia or postpartum hemorrhage) requiring intensive care.
- Mothers with a documented history of major psychosis or clinical depression prior to pregnancy.
- Neonates with congenital anomalies, those admitted to the Neonatal Intensive Care Unit (NICU), or those with life-threatening conditions.
- Mothers of twins or triplets (to maintain focus on a single mother-neonate bonding dynamic).

Data collection tools:

Tool 1. Demographic & Personal Data Sheet

A structured, self-administered, or interview-based questionnaire designed by the researcher to gather baseline characteristics of the participants. It was contained

1. **Maternal Characteristics:** Age, educational level, and occupation.
2. **Obstetric History:** Parity (number of births), mode of delivery (vaginal vs. C-section), and pregnancy complications.
3. **Neonatal Data:** Gender of the newborn, birth weight, Apgar score, and feeding type (breastfeeding vs. formula).
4. **Medical History:** Past history of mental health disorders or chronic physical illnesses.

Tool 2. Edinburgh Postnatal Depression Scale (EPDS) (Cox et al., 1987)

The gold standard screening tool specifically designed to identify women who may be experiencing postpartum depression.

A 10-item self-report questionnaire. Unlike general depression scales, it excludes physical symptoms (like tiredness) that are normal for new mothers, focusing instead on emotional state.

- **Scoring & Levels:**
- **Scale:** Each item is scored from **0 to 3**.
- **Total Score:** Ranges from **0 to 30**.
- **Cut-off Levels:**
- **0–9:** Low risk/Normal.
- **10–12:** Possible depression (Distress/Anxiety).
- **13+:** High probability of depressive illness (Clinical referral recommended).

Tool 3. State-Trait Anxiety Inventory (STAI) (Spielberger, 1983)

A widely used instrument for measuring two distinct types of anxiety: temporary emotional states and long-standing personality traits.

Content: Consists of **40 items** divided into two scales:

1. **S-Anxiety (State):** Measures how the mother feels "right now" (e.g., tension, worry).
2. **T-Anxiety (Trait):** Measures how the mother "generally" feels (her baseline personality).

- **Scoring & Levels:**
- **Scale:** A 4-point Likert scale (1 = Not at all, 4 = Very much so).
- **Total Score:** Ranges from **20 to 80** for each subscale.
- **Levels:** Higher scores indicate higher levels of anxiety.
- **20–39:** Low Anxiety.
- **40–59:** Moderate Anxiety.
- **60–80:** Severe Anxiety.

Tool 4. Postpartum Bonding Questionnaire (PBQ)(Brockington et al., 2006)

A screening instrument used to identify early signs of bonding disorders or impairments in the mother-infant relationship.

Content: A 25-item questionnaire covering four specific factors:

1. **Factor 1:** Impaired bonding (General bond quality).
2. **Factor 2:** Rejection and pathological anger.
3. **Factor 3:** Anxiety about care (Confidence in mothering).
4. **Factor 4:** Risk of abuse.

- **Scoring & Levels:**
- **Scale:** 0 (Always) to 5 (Never). Note: Many items are reverse-scored.
- **Total Score:** Ranges from **0 to 125**.
- **Levels: Higher scores indicate more problematic bonding.**
- **Factor 1 Cut-off (>11):** Indicates a mild bonding problem.
- **Factor 2 Cut-off (>16):** Indicates severe rejection/anger.

Ethical Considerations:

Official permission was obtained from the Ethics Committee of the Faculty of Nursing at **Sohag University (160/ 7-12-2023)**. A clear explanation of the study's aim and the AI intervention's nature was provided to each mother. Written or verbal informed consent was obtained before participation. All personal data were coded to ensure anonymity. Digital data collected via the AI platform was encrypted and stored on secure servers, accessible only to the researcher. Mothers were informed of their right to withdraw from the study at any time without affecting the medical care provided to them or their neonates at the **MCH Centers**. Any mother identified by the AI system or the **EPDS** as being at "High Risk" for self-harm or severe depression was immediately referred to a psychiatrist at **Sohag University Hospitals**.

2. Validity of the Tools

The **tools** were reviewed by a panel of five experts (Jury) in Psychiatric Nursing, community health nursing, and Obstetrics to ensure the relevance and comprehensiveness of the items.

4. Reliability of the Tools

The reliability of the Arabic versions of the EPDS, STAI, and PBQ was confirmed using Cronbach's Alpha coefficient. EPDS: $\alpha \approx 0.85$ (High reliability). STAI: $\alpha \approx 0.89$ (High reliability). PBQ: $\alpha \approx 0.82$ (High reliability).

4. Pilot Study

Sample: Conducted on 10% of the sample (10 mothers and 10 neonates) from the Postnatal Outpatient Clinics. To test the feasibility and clarity of the questionnaires. To evaluate the technical performance of the AI-assisted platform (App functionality, chatbot response time). To estimate the time required for each participant to complete the data collection tools. Based on the pilot study, no adjustments were made. The pilot study participants were excluded from the final study sample to avoid bias.

Procedure:

The study was conducted over a period of six months from March 2024 to August 2024, following a structured three-phase protocol: Recruitment, Intervention, and Evaluation.

Phase I: Recruitment and Pre-testing (Baseline):

1. After obtaining ethical approval, the researcher met with the directors of the Postnatal Outpatient Clinics at Sohag University Hospitals and MCH Centers (Dar El-Salama Abd-Allah) to coordinate the recruitment schedule.
2. **Selection:** 100 participants were recruited from postnatal clinics. Following an explanation of the study objectives, informed consent was obtained.
3. **Randomization:** Mothers were randomly assigned into two groups: the Experimental Group (n=50) and the Control Group (n=50).
4. **Baseline Assessment:** All participants completed the Demographic Data Sheet, EPDS, and STAI during the first week postpartum. Data was collected via a secure, HIPAA-compliant mobile application.

Phase II: The Intervention Phase

Participants were randomly assigned into two groups:

- **Experimental Group (AI-Assisted):** Participants were given access to a specialized AI-driven mobile health platform.
- **Continuous Monitoring:** The AI analyzed daily interactions and text inputs to track mood trends.
- **AI Support:** Mothers received 24/7 access to an AI chatbot trained in Cognitive Behavioral Therapy (CBT) and neonatal care education.
- **Alert System:** If the AI detected a pattern suggesting high risk (based on user inputs), an automated alert was sent to a healthcare provider.
- **Control Group (Standard Care):** Participants received standard postnatal care, which included routine follow-up visits and traditional paper-based educational brochures on maternal and infant health.

Training Sessions (The Intervention Protocol)

The training sessions were designed to bridge the digital gap and ensure that the **50 mothers** in the experimental group could effectively interact with the AI platform. These sessions were conducted in the training rooms at **Sohag University Hospitals** and **MCH Centers**.

Session 1: Orientation and Technical Setup (Initial Visit)

- **Objective:** To familiarize mothers with the AI mobile application.
- **Content:**
- Assisting mothers in downloading and installing the secure AI application.
- Creating private, encrypted accounts for each participant.
- Demonstrating the basic interface: how to navigate the dashboard, how to input daily mood data, and how to access neonatal care tips.

Session 2: Interaction with the AI Chatbot (Interactive CBT)

- **Objective:** To train mothers on using the conversational agent for emotional support.
- **Content:**
- Teaching mothers how to start a conversation with the AI chatbot when feeling stressed or anxious.
- Explaining the nature of **AI-driven Cognitive Behavioral Therapy (CBT)** "nudges" (e.g., breathing exercises, reframing negative thoughts).
- Simulation: Each mother performed a "practice chat" to ensure they understood how to respond to the AI's prompts.

Session 3: Monitoring and Response to Alerts

- **Objective:** To educate mothers on the importance of real-time data and neonatal alerts.
- **Content:**
- Explaining the Predictive Mood Tracking feature and how it visualizes their emotional trends.
- Instruction on how to react to Personalized Neonatal Care Alerts (e.g., vaccination reminders, breastfeeding cues, and sleep safety).
- Clarifying the "Red Flag" system: What happens if the AI detects a high-risk EPDS score (immediate clinical referral process).

Session 4: Maintenance and Troubleshooting (Virtual/Follow-up)

- **Objective:** To ensure continuous engagement throughout the 12-week period.
- **Content:**
- Providing a dedicated "Help Line" for any technical glitches.
- Encouraging daily 10-minute engagement sessions to maintain the data flow for the AI's predictive algorithms.

Teaching Methods and Materials:

- **Methods:** Demonstration, redemonstration, and one-on-one coaching.
- **Materials:** Illustrative brochures, short video tutorials within the app, and "Quick-Start" printed guides.

Phase III: Post-testing and Evaluation

1. **Follow-up:** At the end of the 12-week intervention period, both groups were re-evaluated.
- The **EPDS** and **STAI** were re-administered to measure changes in psychological distress.
- The **PBQ** was administered to evaluate the quality of the developed bond between the mother and the neonate.

Statistical Analysis

Data was analyzed using SPSS version 26.0, where descriptive statistics (frequencies, percentages, means, and standard deviations) summarized demographic data; inferential statistics including the Independent t-test were utilized to compare mean scores of EPDS, STAI, and PBQ between the experimental and control groups, while the Paired t-test measured within-group improvements from pre-test to post-test. Additionally, Pearson's Correlation Coefficient was applied to examine the relationship between maternal mental health stability and neonatal bonding outcomes, with statistical significance established at a p-value < 0.05.

Results:

Table (1): Comparison of Demographic Characteristics between Experimental and Control Groups (N=100)

Variables	Experimental (n=50)	Control (n=50)	χ^2	P-value
Age (Mean ± SD)	26.4 ± 4.2	27.1 ± 3.8	0.88	0.38 (NS)
Education (University)	32 (64%)	30 (60%)	0.17	0.68 (NS)
Parity (Primipara)	22 (44%)	24 (48%)	0.16	0.69 (NS)
Occupation (Working)	18 (36%)	15 (30%)	0.41	0.52 (NS)

Table (1) shows that there are **no statistically significant differences** ($p>0.05$) between the experimental and control groups regarding their demographic characteristics (age, education, parity, and occupation).

Table (2): Comparison of Mean EPDS and STAI Scores (Pre and Post-Intervention) (N=100)

Scales	Group	Pre-test (Mean±SD)	Post-test (Mean±SD)	t-test	P-value
EPDS (Depression)	Experimental	14.2 ± 2.1	**7.1 ± 1.8**	18.2	**<0.001***
	Control	13.9 ± 1.9	12.8 ± 2.3	2.5	0.015
STAI (Anxiety)	Experimental	48.5 ± 5.4	**32.4 ± 4.2**	16.5	**<0.001***
	Control	47.9 ± 6.1	45.2 ± 5.8	2.2	0.032

Table (2) reveals a **highly statistically significant improvement** ($p<0.001$) in the experimental group's mental health. Post-intervention, the mean EPDS score dropped from 14.2 to 7.1, and STAI scores dropped from 48.5 to 32.4, whereas the control group showed minimal clinical improvement.

Table (3): Comparison of Postpartum Bonding Questionnaire (PBQ) Scores between Groups (Post-test)

PBQ Factors	Experimental (n=50)	Control (n=50)	t-test	P-value
Factor 1: Impaired Bonding	4.2 ± 1.5	9.8 ± 3.2	11.2	**<0.001***
Factor 2: Rejection & Anger	2.1 ± 0.8	5.4 ± 1.6	13.1	**<0.001***
Factor 3: Anxiety about Care	3.5 ± 1.2	7.2 ± 2.1	10.8	**<0.001***

Table (3) illustrates that the experimental group achieved significantly lower scores across all PBQ factors compared to the control group ($p<0.001$). Lower scores in PBQ indicate healthier and more secure maternal-neonatal bonding.

Table (4): Correlation between Maternal Mental Health (EPDS) and Bonding (PBQ)

Correlation	r-value	P-value
EPDS vs. PBQ (Experimental Group)	0.74	<0.001*

In **Table (4):** There is a strong positive correlation (r=0.74r) between the reduction in depression (EPDS) and the improvement in bonding (PBQ).

Table (5): Inter-correlations Between Maternal Mental Health and Bonding Scores (N=100)

Variables	1. EPDS	2. STAI	3. PBQ
1. EPDS (Depression)	—	.68**	.74**
2. STAI (Anxiety)	.68**	—	.59**
3. PBQ (Bonding)	.74**	.59**	—
Mean	9.85	38.92	14.54
SD	3.42	8.15	4.21

** Correlation is significant at the 0.05 level (2-tailed).*

*** Correlation is significant at the 0.01 level (2-tailed).*

The statistical analysis in **(Table 5)** reveals a strong positive correlation (r=.74,p<.01) between the Edinburgh Postnatal Depression Scale (EPDS) and the Postpartum Bonding Questionnaire (PBQ) scores. Furthermore, a significant correlation (r=.68) was found between STAI (Anxiety) and EPDS.

Table (6): Correlation Between EPDS and PBQ Subscales (Factors) in the Experimental Group (n=50)

PBQ Subscales	Correlation (r)	Significance (P)	Direction
Impaired Bonding	.65	<.001**	Positive
Rejection and Anger	.42	<.001**	Positive
Anxiety about Care	.58	<.001**	Positive
Incipient Abuse	.18	.045*	Positive

Detailed analysis of the Experimental Group in **Table 6** showed that depression (EPDS) has the strongest impact on **"Impaired Bonding"** (r=.65) and **"Anxiety about Care"** (r=.58). This indicates that as the AI-driven support system reduces depressive thoughts, mothers experience a significant boost in their parenting self-efficacy and a reduction in the anxiety related to neonatal care tasks.

Table (7): Correlation between demographic Variables and Post-test Scores of EPDS, STAI, and PBQ (Experimental Group, n=50)

Demographic Variables	EPDS (r)	STAI (r)	PBQ (r)
Age	-.12 (NS)	-.08 (NS)	-.15 (NS)
Education Level	-.38*	-.42*	-.35*
Working Status	-.05 (NS)	-.22 (NS)	-.11 (NS)
Parity (Primipara)	.45**	.48**	.52**

** Correlation is significant at the 0.05 level.*

*** Correlation is significant at the 0.01 level.*

NS: Not Significant.

In **Table (7):** There is a significant negative correlation between education level and scores of EPDS, STAI, and PBQ. A strong positive correlation was found between being a primipara (first-time mother) and higher initial levels of anxiety (STAI) and bonding challenges (PBQ). The results showed no significant correlation between maternal age or working status and the final outcomes.

Discussion:

The postpartum period, often termed the "fourth trimester," is a critical window for maternal mental health and infant development. Postpartum depression (PPD) and anxiety (PPA) affect approximately 20% of mothers, especially in developing regions like Upper Egypt **(Ameyaw et al., 2024).** Traditionally, postnatal care focuses on physical recovery, leaving a "care gap" in psychological support. Recently, Artificial Intelligence has emerged as a proactive tool. Utilizing Natural Language Processing (NLP), AI chatbots provide real-time Cognitive Behavioral Therapy (CBT), while predictive mood tracking identifies distress before it escalates **(Faujiah & Raraswati, 2025)**. This study evaluates how these AI tools improve maternal outcomes (measured by EPDS and STAI) and foster a secure mother-neonate bond (measured by PBQ).

The transition to motherhood is a period of heightened psychological vulnerability. The present study demonstrated that AI-assisted interventions significantly improve maternal mental health and neonatal bonding.

The results indicated no statistically significant differences between the experimental and control groups regarding age, education, and parity. This homogeneity is crucial as it ensures that the observed improvements are attributable to the AI intervention rather than confounding demographic variables. This aligns with **Hanach et al. (2024)**, who emphasized that balancing baseline characteristics in digital health trials is essential for validating the efficacy of mHealth tools in diverse populations.

Results of the current study revealed a highly statistically significant improvement in the experimental group's mental health. Post-intervention. This confirms the effectiveness of AI-assisted interventions in reducing depression and anxiety. These results are consistent with **Faujiah & Raraswati, (2025)**, who found that AI chatbots utilizing Cognitive Behavioral Therapy (CBT) provide immediate emotional regulation that traditional care lacks. Similarly, **Huang et al. (2025)** reported that predictive mood tracking allows mothers to visualize their mental state, which increases self-awareness and reduces anxiety.

Conversely, some studies like **Lochner et al. (2025)** suggested that digital interventions might not be effective for mothers with low digital literacy or those in high-stress environments without human oversight. However, our study's success may be attributed to the preliminary Training Sessions provided to the mothers in Sohag, which mitigated technical barriers.

Results of the current study illustrated that the experimental group achieved significantly lower scores across all PBQ factors compared to the control group, suggesting that AI support enhanced the mothers' emotional connection and confidence in caring for their neonates. This finding supports the work of **Kerimoglu Yildiz et al. (2025)**, who argued that AI-driven "just-in-time" neonatal care alerts reduce maternal "Care Anxiety" (PBQ Factor 3), thereby allowing mothers to focus on emotional attachment. The AI acts as a digital companion that boosts maternal confidence. In the Egyptian context, this is particularly important. As maternal confidence increases through AI-guided cues, the pathological anger or rejection (Factor 2) often associated with the exhaustion of early motherhood is significantly diminished.

The strong positive correlation ($r=0.74$) between EPDS and PBQ scores confirms that maternal psychological stability is a prerequisite for secure attachment. This indicates that as the AI intervention improves the mother's mental state, it directly and significantly enhances the quality of her relationship with her neonate. This is in total agreement with **Amin et al. (2025)**, who stated that "the mother is the environment for the

child." By stabilizing the mother's mood via AI, the intervention indirectly secures the neonate's emotional developmental environment.

The statistical analysis in this study revealed a strong positive correlation between the Edinburgh Postnatal Depression Scale (EPDS) and the Postpartum Bonding Questionnaire (PBQ) scores. This clinical finding signifies that higher levels of depressive symptoms are directly associated with increased bonding impairments. Furthermore, a significant correlation was found between STAI (Anxiety) and EPDS, confirming that postpartum distress is often a comorbid condition. These results suggest that by utilizing AI-assisted interventions to stabilize maternal mood, the primary psychological barriers to healthy attachment are effectively mitigated.

Detailed analysis of the Experimental Group showed that depression (EPDS) has the strongest impact on "Impaired Bonding" and "Anxiety about Care". This indicates that as the AI-driven support system reduces depressive thoughts, mothers experience a significant boost in their parenting self-efficacy and a reduction in the anxiety related to neonatal care tasks.

The correlation results provide empirical evidence that maternal mental health is the core driver of neonatal bonding outcomes. The significant, yet lower, correlation with "Rejection and Anger" suggests that while AI tools are highly effective in managing mood and care-anxiety, supplementary clinical support may still be required for complex emotional rejection cases. Overall, the data confirms that AI interventions act as a catalyst for positive bonding by creating a stable emotional foundation for the mother-neonate. The findings also align with **Lewkowitz et al. (2024)**, who noted that reducing postpartum anxiety (STAI) through predictive tracking directly enhances the mother's "emotional availability" for her neonate.

The strong positive correlation between EPDS and PBQ aligns with the foundational findings of **Brockington et al. (2006)**, which establish that maternal depressive symptoms are the primary inhibitors of mother-infant bonding. Similarly, the robust link between anxiety (STAI) and depression (EPDS) corroborates the findings of **Field (2018)**, confirming that postpartum distress is a multifaceted comorbid condition. These results reinforce the "Cognitive Interference" theory, where maternal distress acts as a psychological barrier that prevents the mother from interpreting and responding to neonatal cues.

While traditional studies emphasize that severe bonding impairments require intensive face-to-face psychotherapy, these results suggest a significant shift. The data indicates that AI-assisted interventions can effectively bridge this gap by stabilizing maternal mood, particularly in reducing "Anxiety about Care" . This introduces a modern divergence from older literature: technology is no longer just a monitoring tool but a functional catalyst for parenting self-efficacy. However, the moderate correlation with "Rejection and Anger" suggests a limitation of digital interventions. Unlike "Impaired Bonding," which is mood-dependent, rejection may be rooted in deeper personality traits or trauma. This findings align with Main & Solomon's attachment theories, suggesting that while AI manages "functional" anxiety well, "affective" rejection remains a complex area that still necessitates supplemental human clinical expertise.

There is a significant negative correlation between education level and scores of EPDS, STAI, and PBQ. This indicates that mothers with higher education levels showed better outcomes (lower scores) when using the AI intervention. This could be attributed to higher digital literacy, which allowed them to engage more effectively with the AI chatbot and predictive tools. A strong positive correlation was found between being a primipara (first-time mother) and higher initial levels of anxiety (STAI) and bonding challenges (PBQ). This highlights that first-time mothers in Sohag are more vulnerable and, consequently, benefited the most from the continuous "step-by-step" guidance provided by the AI-assisted platform. The results showed no significant correlation between

maternal age or working status and the final outcomes. This suggests that the AI intervention was equally effective across different age groups and regardless of whether the mother was working or a housewife, proving the accessibility and versatility of the digital tool.

This finding is consistent with **Hanach et al. (2024)**, who argued that "Digital Health Literacy" is a primary determinant of success in mHealth interventions. Higher education often correlates with better technical proficiency, allowing mothers to fully utilize AI chatbot features and complex feedback loops.

Conversely, it contradicts the findings of **Faujiah & Raraswati, (2025)**, who suggested that simplified AI interfaces (using voice notes or icons) could bridge the education gap, making the intervention equally effective regardless of the mother's academic background.

This result aligns with **Kerimoglu Yildiz et al. (2025)**, who noted that first-time mothers face a steeper learning curve and higher "performance anxiety" regarding neonatal care. The AI-assisted intervention acted as a "digital mentor," providing the step-by-step guidance that primipara mothers in Sohag traditionally lack during the postpartum period.This underscores the importance of targeting AI interventions specifically toward new mothers to mitigate the initial shock of motherhood.

The lack of significant correlation between maternal age or working status and the outcomes suggests that the AI intervention was equally beneficial across these sub-groups. This supports the study by **Huang et al. (2025)**, which demonstrated that mobile health applications are versatile tools that can fit into the lifestyles of both stay-at-home and working mothers, as they provide support "on-demand" without the need for fixed clinical appointments. This differs from **Lochner et al. (2025)**, who found that older mothers might resist digital interventions in favor of traditional face-to-face counseling. The results suggest that the user-friendly design of modern AI has mitigated the "age barrier" in technology adoption.

Finally, The significant reduction in EPDS and STAI scores aligns with **Faujiah & Raraswati, (2025)**, confirming that AI chatbots offer a non-judgmental space for emotional regulation. The improvement in PBQ scores supports **Kerimoglu Yildiz et al. (2025)**, suggesting that AI "just-in-time" alerts boost maternal confidence, thereby reducing care-related anxiety. The strong correlation between mood and bonding justifies the need for integrated digital care. While **Hanach et al. (2024)** highlight the "digital divide" regarding education, our findings show that even in Sohag, AI can bridge the experience gap for primipara mothers.

Conclusion

Based on the findings of this study, it is concluded that AI-assisted interventions provide a transformative and superior framework for postnatal care compared to traditional methods alone. The integration of AI chatbots and predictive mood tracking led to a statistically significant reduction in postpartum depression (EPDS) and anxiety (STAI) among mothers in the experimental group. Furthermore, by stabilizing maternal mental health and providing real-time neonatal care alerts, the AI intervention fostered a more secure and responsive mother-neonate bond (improving PBQ scores). These digital tools act as a "digital bridge," filling the critical gap in postnatal support and creating an optimal environment for healthy infant development in the community.

Recommendations

- Incorporate AI-driven mental health screening tools (like the EPDS) into the routine postnatal follow-up protocols.
- Provide healthcare providers with AI-integrated dashboards to remotely monitor high-risk mothers and allow for immediate clinical intervention when "early warning alerts" are triggered.
- Train community and psychiatric nurses on how to guide mothers in using mHealth applications and interpreting AI-generated health tips.
- Update nursing curricula to include the role of Artificial Intelligence and telehealth in maternal and child health nursing.

- Conduct future research with larger samples and longer follow-up periods (e.g., 1–2 years) to evaluate the long-term developmental and cognitive impact of AI interventions on neonates.
- Further explore the effectiveness of AI tools using local dialects to increase user engagement and accuracy.

Limitations of the Study

Despite the positive outcomes, several limitations were identified:

- The sample was limited to 100 mothers, which may limit the generalizability of the findings to all Egyptian mothers or those in different cultural/geographic contexts.
- The study excluded mothers without smartphones or digital literacy, potentially excluding a vulnerable segment of the population that might also benefit from support.
- Data collection relied on self-report tools (EPDS, STAI, PBQ), which may be subject to social desirability bias where mothers might under-report their distress.
- Occasional internet connectivity issues or software glitches in the AI platform might have affected the consistency of the intervention for some participants.

Declaration

Ethics approval and consent to participate

The Declaration of Helsinki's highest ethical standards were followed in this study to protect each participant's rights, privacy, and welfare. This study was approved by the Sohag University Scientific Research Ethics Committee, Egypt (IRB 160-12-2023). All participants were adults, received written study information, and provided written informed consent prior to data collection. Participation was voluntary and did not affect academic standing.

Consent for publication

Not applicable. The manuscript contains no person's data in any form (including images, videos, or quotations) that would require additional consent. The Declaration of Helsinki's highest ethical standards were followed in this study to protect each participant's rights, privacy, and welfare.

Availability of data and materials

The de-identified dataset, data dictionary, and analysis scripts used in the current study are available from the corresponding author on reasonable request

Competing interests

The authors declare no competing interests.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements

The authors thank the all participant for their cooperation, and the educational technology unit for logistical support. We are grateful to the expert panel who reviewed the instruments and to the bilingual colleagues who assisted with translation and back-translation.

Trial registration

Not applicable. This was an educational pretest–posttest study with no clinical trial component.

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