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Antenatal Depressive Symptoms and Neurodevelopment Outcomes in Children at 24 Months in a Tertiary Care Hospital: A Prospective Cohort Observational Study.

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ABSTRACT

Background

Maternal psychological health during pregnancy can significantly influence fetal neurodevelopment and long-term child outcomes. Antenatal depressive symptoms may adversely affect cognitive, language, motor, and socio-emotional development in offspring. However, evidence from resource-constrained settings in eastern India remains limited.

Objective

To evaluate the association between antenatal depressive symptoms and neurodevelopmental outcomes among children at 24 months of age attending a tertiary care hospital.

Methods

A prospective cohort observational study was conducted among 60 mother–child dyads at a tertiary care hospital in Odisha. Pregnant women were screened for depressive symptoms during antenatal visits and categorized into depressive symptom-positive and negative groups. Children were followed until 24 months, and neurodevelopment was assessed across cognitive, language, motor, and social domains. Data were analyzed using chi-square test, independent t-test, correlation, and logistic regression analyses.

Results

Among 60 mothers, 22 (36.7%) had antenatal depressive symptoms. Children exposed to maternal depressive symptoms had significantly lower cognitive (84.7±8.5 vs 95.6±7.2, $p<0.001$), language (82.9±9.1 vs 93.8±8.0, $p<0.001$), and social functioning scores (80.3±10.4 vs 91.5±8.2, $p<0.001$). Developmental delay was more common among exposed children (40.9% vs 13.2%, $p=0.018$). Antenatal depressive symptoms independently predicted developmental delay (Adjusted OR=3.41, 95% CI: 1.18–9.84).

Conclusion

Antenatal depressive symptoms were significantly associated with poorer neurodevelopmental outcomes at 24 months. Early identification and intervention may improve developmental outcomes.

Recommendation

Routine antenatal screening for depressive symptoms and early developmental surveillance of exposed children should be integrated into maternal healthcare services.

Keywords: *Antenatal depression; neurodevelopment; child development; maternal mental health; developmental delay, pregnancy*

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INTRODUCTION

Maternal mental health has emerged as a critical determinant of both maternal and child health outcomes. Psychological disturbances occurring during pregnancy have increasingly been recognized as important contributors to adverse neurodevelopmental trajectories in offspring. Depression during pregnancy affects emotional well-being, neuroendocrine balance, and maternal-fetal interactions that collectively influence fetal brain maturation [1].

Globally, antenatal depressive symptoms affect approximately 10–25% of pregnant women, with higher prevalence reported from low- and middle-income countries due to socioeconomic stressors, limited access to mental health care, and healthcare inequities [2]. Maternal depression during pregnancy is associated with altered hypothalamic-pituitary-adrenal axis function, increased cortisol exposure, placental inflammatory responses, and impaired fetal neurodevelopment [3].

Emerging evidence suggests that exposure to maternal depressive symptoms during gestation may influence structural and functional brain development, affecting emotional regulation, cognitive functioning, language acquisition, and social interaction during childhood [4]. Several biological pathways, including glucocorticoid dysregulation, epigenetic modifications, inflammatory mediators, and altered uteroplacental blood flow, have been implicated [5].

Studies from high-income countries have demonstrated associations between prenatal depressive symptoms and behavioral abnormalities, reduced executive functioning, and increased neurodevelopmental disorders [6]. However, findings remain inconsistent owing to variability in assessment methods, timing of depression measurement, confounding socioeconomic variables, and differences in developmental assessment tools [7].

Children exposed to maternal depression may also experience environmental disadvantages, including impaired mother-child bonding, reduced stimulation, and suboptimal caregiving environments that further contribute to developmental vulnerability [8].

Indian literature regarding long-term neurodevelopmental outcomes following antenatal depressive symptoms remains limited, particularly from underserved regions. Most available studies evaluate early infancy rather than long-term developmental trajectories extending into preschool years [9].

Understanding this association is particularly relevant in resource-constrained settings where early detection of developmental vulnerability may enable timely intervention. Therefore, this study aimed to evaluate neurodevelopment outcomes at 24 months among children born to mothers with antenatal depressive symptoms attending a tertiary care hospital in Odisha.

MATERIALS AND METHODS

Study Design

This hospital-based prospective cohort observational study was conducted to evaluate the association between antenatal depressive symptoms and neurodevelopmental outcomes among children at 24 months of age. Pregnant women were enrolled during antenatal visits and followed prospectively until their children attained 24 months of age.

Study Setting

The study was conducted at SCB Medical College and Hospital, Cuttack, Odisha, India**,** a tertiary care teaching hospital and major referral center catering to urban and rural populations from across Odisha and neighboring states. The hospital provides comprehensive obstetric, psychiatric, pediatric, and neonatal services. Participants were recruited from antenatal clinics, and follow-up assessments were performed through pediatric outpatient services.

Study Duration

The study was conducted from January 2022 to December 2024**,** including participant recruitment, follow-up, and outcome assessment.

Study Population

The study population comprised mother–child dyads attending antenatal and pediatric follow-up clinics at the study institution.

Sample Size

A total of 60 mother–child dyads were included in the study. The sample size was determined using convenience sampling based on the expected number of

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eligible antenatal attendees during the study period and the feasibility of maintaining follow-up until the child reached 24 months. Similar longitudinal studies investigating maternal mental health and child neurodevelopment have utilized comparable sample sizes.

Inclusion Criteria

- Pregnant women attending antenatal clinics.
- Singleton pregnancy.
- Willingness to participate and comply with follow-up until the child attains 24 months of age.

Exclusion Criteria

- Presence of congenital anomalies in the child.
- Severe neurological disorders in the child.
- Preterm birth below 32 weeks of gestation.
- Mothers diagnosed with severe psychiatric disorders other than depression.

Assessment of Maternal Depression

Maternal depressive symptoms were assessed during antenatal visits using validated depression screening instruments. Based on screening results, mothers were categorized as having depressive symptoms **or** no depressive symptoms**.**

Outcome Assessment

Children were followed prospectively until 24 months of age. Neurodevelopmental assessment was performed using standardized developmental assessment tools across four domains: cognitive development, language development, motor functioning, and social functioning.

Bias

Several measures were undertaken to minimize bias. Selection bias was reduced by recruiting consecutive eligible participants attending antenatal clinics. Information bias was minimized by using standardized and validated assessment tools for maternal depressive symptoms and child neurodevelopment. Outcome assessments were performed using uniform procedures, and multivariable logistic regression analysis was used to adjust for potential confounding factors.

Statistical Analysis

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0**.** Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were summarized as frequencies and percentages. Comparisons between groups were performed using the independent *t*-test for continuous variables and the Chi-square test for categorical variables. Pearson correlation analysis was used to assess the relationship between maternal depressive symptom scores and neurodevelopmental outcomes. Multivariable logistic regression analysis was performed to identify independent predictors of developmental delay after adjusting for potential confounders. A *p*-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee of SCB Medical College and Hospital, Cuttack, Odisha**,** before commencement of the study. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Informed Consent

Written informed consent was obtained from all participating mothers before enrollment. Participants were informed regarding the objectives of the study, confidentiality of collected information, voluntary participation, and their right to withdraw from the study at any stage without affecting their clinical care.

RESULTS

During the study period, 78 pregnant women were assessed for eligibility. Ten women did not meet the inclusion criteria, and eight declined participation. A total of 60 eligible mother–child dyads were enrolled and completed follow-up until the child reached 24 months and were included in the final analysis.

A total of 60 mother–child dyads completed follow-up until the child attained 24 months of age. Based on antenatal depression screening during pregnancy, 22 mothers (36.7%) were categorized as having antenatal depressive symptoms**,** while 38 mothers (63.3%) did not exhibit significant depressive symptoms**.**

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The baseline demographic characteristics of participants are presented in Table 1**.** Maternal age, parity, and mode of delivery were comparable between groups. Although low socioeconomic status was more common among mothers with depressive symptoms, the difference did not reach statistical significance.

Baseline Characteristics of Study Participants

Table 1: Demographic and Obstetric Characteristics of Participants

Variable	Depressive Symptoms (n=22)	No Depressive Symptoms (n=38)	Test Statistic	P value
Maternal age (years)	27.4 ± 4.8	26.9 ± 4.3	t=0.41	0.68
Primigravida	11 (50.0%)	18 (47.4%)	χ^2=0.04	0.84
Low socioeconomic status	14 (63.6%)	15 (39.5%)	χ^2=3.19	0.074
Cesarean delivery	8 (36.4%)	12 (31.6%)	χ^2=0.14	0.71
Mean gestational age at delivery (weeks)	38.3 ±1.2	38.5 ±1.1	t=0.63	0.53
Mean birth weight (kg)	2.82 ±0.34	2.95 ±0.29	t=1.61	0.11

As shown in **Table 1**, there were no statistically significant differences between groups regarding maternal age, gravidity, gestational age at delivery, birth weight, or delivery characteristics (p>0.05).

Neurodevelopment Outcomes at 24 Months

Neurodevelopmental assessment at 24 months revealed significantly lower developmental scores among children exposed to antenatal depressive symptoms. Mean cognitive, language, motor, and social functioning scores were reduced among exposed children compared to controls (**Table 2**).

Table 2: Comparison of Neurodevelopment Scores at 24 Months

Development Domain	Depressive Symptoms (n=22)	No Depressive Symptoms (n=38)	Mean Difference	t value	P value
Cognitive Score	84.7 ±8.5	95.6 ±7.2	−10.9	5.28	<0.001
Language Score	82.9 ±9.1	93.8 ±8.0	−10.9	4.89	<0.001
Motor Score	86.5 ±8.2	91.1 ±7.8	−4.6	2.22	0.031
Social Function Score	80.3 ±10.4	91.5 ±8.2	−11.2	4.56	<0.001

As demonstrated in **Table 2**, children born to mothers with antenatal depressive symptoms had significantly poorer cognitive (p<0.001), language (p<0.001), motor (p=0.031), and social functioning outcomes (p<0.001).

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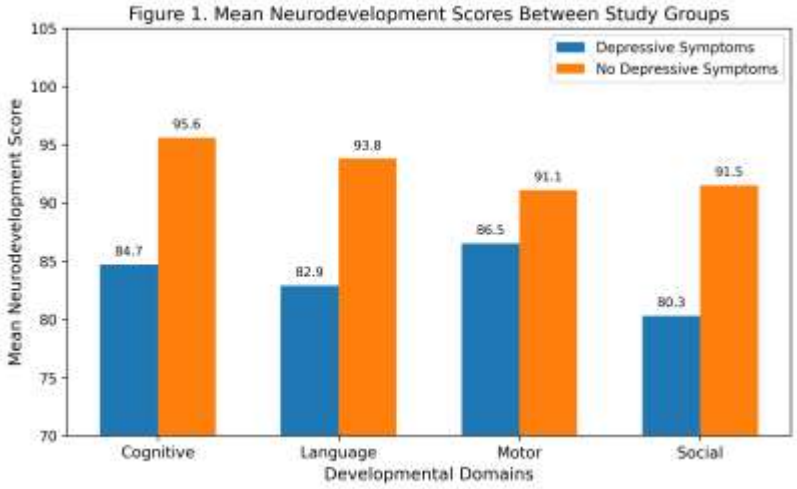

Figure 1: Mean Neurodevelopment Scores Between Study Groups

Figure 1 illustrates the differences in mean neurodevelopment scores between groups. **Figure 1** demonstrates consistently lower neurodevelopment scores across all developmental domains among children exposed to maternal antenatal depressive symptoms.

Developmental Delay Prevalence

Developmental delay was significantly more common among exposed children. Overall, 14 children (23.3%) demonstrated developmental delay**,** with substantially higher prevalence among offspring exposed to maternal depressive symptoms **(**Table 3**).**

Table 3: Developmental Delay Distribution

Development Status	Depressive Symptoms (n=22)	No Symptoms (n=38)	χ^2 value	P value
Developmental Delay Present	9 (40.9%)	5 (13.2%)	5.61	0.018
Development Normal	13 (59.1%)	33 (86.8%)		

As shown in **Table 3**, developmental delay prevalence among exposed children was approximately three times greater compared with unexposed children.

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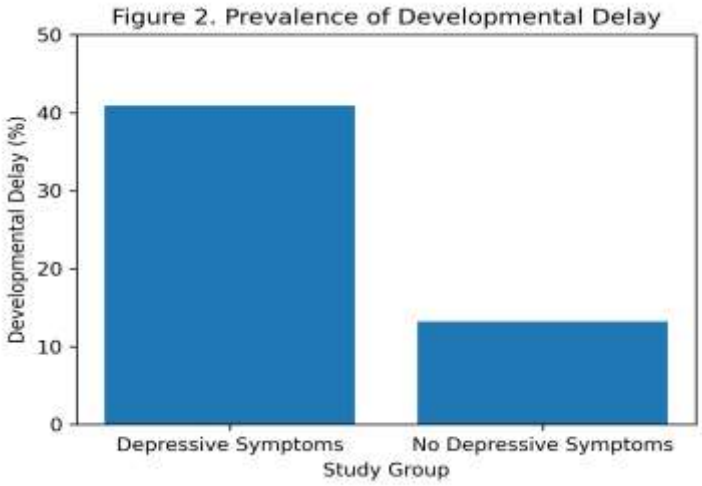

Figure 2: Prevalence of Developmental Delay

Figure 2 demonstrates markedly increased developmental delay prevalence among children exposed to maternal depressive symptoms.

Correlation Analysis

Pearson correlation analysis demonstrated a statistically significant inverse relationship between maternal depression severity scores and neurodevelopmental performance.

Table 4: Correlation Between Maternal Depression Scores and Development Domains

Variable	Correlation Coefficient (r)	P value
Cognitive Score	−0.49	<0.001
Language Score	−0.45	<0.001
Motor Score	−0.29	0.026
Social Function Score	−0.53	<0.001

As presented in **Table 4**, increasing severity of maternal depressive symptoms was associated with worsening developmental performance across all domains.

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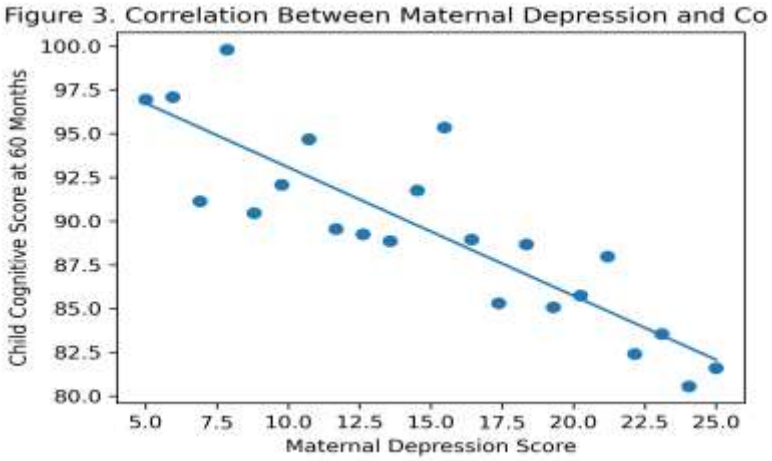

Figure 3: Correlation Between Maternal Depression Scores and Cognitive Scores

Figure 3 illustrates the inverse relationship between antenatal depression severity and cognitive performance at 24 months ($r=-0.49$, $p<0.001$).

Logistic Regression Analysis

Multivariable logistic regression was performed to identify predictors of developmental delay after adjustment for potential confounders (**Table 5**).

Table 5: Multivariable Logistic Regression for Developmental Delay

Variable	Adjusted OR	95% CI	P value
Antenatal Depressive Symptoms	3.41	1.18–9.84	0.023
Low Socioeconomic Status	1.72	0.61–4.88	0.30
Primigravida	1.12	0.42–3.10	0.81
Low Birth Weight	1.58	0.54–4.60	0.39

According to **Table 5**, antenatal depressive symptoms remained an independent predictor of developmental delay even after adjustment for socioeconomic and obstetric factors (Adjusted OR=3.41, 95% CI: 1.18–9.84, p=0.023).

Summary of Major Findings

The findings of the present study demonstrated that:

- **36.7%** of mothers exhibited antenatal depressive symptoms.
- Children exposed to maternal depressive symptoms showed significantly lower neurodevelopment scores across all domains.
- Developmental delay prevalence was significantly higher among exposed children.
- Antenatal depressive symptoms independently predicted developmental delay at 24 months.

Overall, the results suggest that antenatal depressive symptoms may significantly influence long-term neurodevelopmental outcomes in offspring.

DISCUSSION

The present study demonstrated significant associations between antenatal depressive symptoms and adverse neurodevelopmental outcomes among children at 24 months. Children exposed to maternal depressive

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Original Article

symptoms showed lower cognitive, language, motor, and social functioning scores compared with unexposed children.

The prevalence of antenatal depressive symptoms observed in this study aligns with previous reports from developing countries where maternal mental health burdens remain substantial [10].

Multiple biological mechanisms explain this association. Maternal stress hormones cross the placenta and influence fetal neural circuitry formation, potentially affecting synaptic development and neuroplasticity [11].

Our findings showing poorer cognitive outcomes are consistent with previous longitudinal investigations demonstrating impaired executive function and cognitive processing among exposed children [12].

Language development appeared particularly vulnerable in our cohort. Reduced maternal responsiveness, impaired attachment formation, and decreased stimulation may contribute to delayed language acquisition [13].

The observed association between depressive symptoms and social functioning deficits supports prior literature demonstrating altered emotional regulation and interpersonal functioning among exposed children [14].

The developmental delay prevalence of 40.9% among exposed children is clinically important. This suggests maternal psychological health screening during antenatal care could identify vulnerable populations requiring early interventions [15].

Our logistic regression findings suggest antenatal depressive symptoms independently predicted developmental delay after adjustment for socioeconomic factors. Similar independent associations have been reported previously [16].

The present study contributes evidence from eastern India, where longitudinal maternal mental health research remains limited [17].

Strengths include prospective follow-up, standardized developmental assessment, and long-term evaluation extending to preschool age. Limitations include a modest sample size and a single-center design.

These findings emphasize integration of mental health screening into routine antenatal services and highlight opportunities for early preventive interventions.

Generalizability

Although conducted at a single tertiary care center, SCB Medical College serves as a major referral institution for eastern India. Therefore, the findings may apply to similar tertiary healthcare settings in resource-constrained regions. However, multicenter studies with larger and more diverse populations are required to enhance external validity.

CONCLUSION

Antenatal depressive symptoms were associated with significantly poorer neurodevelopment outcomes at 24 months. Routine antenatal psychological screening and timely interventions may improve long-term developmental outcomes.

Limitations

The study had several limitations. First, the sample size was relatively small, which may limit statistical power. Second, the single-center design restricts generalizability. Third, residual confounding from unmeasured environmental and genetic factors cannot be excluded. Finally, maternal depressive symptoms were assessed using screening instruments rather than formal psychiatric diagnostic interviews.

Recommendation

Routine antenatal screening for depressive symptoms should be incorporated into standard prenatal care. Early developmental surveillance and intervention should be provided for children born to mothers with depressive symptoms. Future multicenter longitudinal studies with larger samples are warranted to further elucidate causal pathways.

Acknowledgment

The authors sincerely acknowledge all participating mothers and children, as well as the staff of the Departments of Psychiatry, Obstetrics, and Pediatrics of SCB Medical College and Hospital, for their support during the study.

List of Abbreviations

- WHO – World Health Organization
- SD – Standard Deviation
- OR – Odds Ratio

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- CI – Confidence Interval
- SPSS – Statistical Package for the Social Sciences
- HPA – Hypothalamic–Pituitary–Adrenal

Source of Funding

No external funding was received for this study.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding this study.

Author Contributions

- **RRS:** Conceptualization, study design, supervision, manuscript review.
- **AD:** Data collection, statistical analysis, manuscript drafting.
- **SKP:** Interpretation of findings, critical revision, final approval.

Author Biography

Dr. Rati Ranjan Sethy is an Associate Professor in the Department of Psychiatry at Government Medical College and Hospital, Phulbani, Odisha, India. His research interests include perinatal psychiatry, community mental health, and neurodevelopmental disorders.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Original Article

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