

Impact of Antenatal Psychological Distress on Early Infant Neurodevelopment and Behavior: A Pediatric Perspective

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Abstract

Background:

Maternal psychological wellbeing during pregnancy plays an essential role in fetal growth and early childhood neurodevelopment. Antenatal psychological distress, including anxiety, stress, and depressive symptoms, has been associated with alterations in fetal neurodevelopment that may influence infant cognitive and behavioral functioning after birth. Early identification of these maternal psychological factors is important in pediatric healthcare because developmental disturbances during infancy may contribute to long-term neurobehavioral complications.

Objective:

To evaluate the impact of antenatal psychological distress on cognitive, behavioral, and neurodevelopmental outcomes in early infancy at a tertiary care hospital in Lahore, Pakistan.

Methods:

This prospective observational study was conducted in the Departments of Pediatrics and Obstetrics at a tertiary care teaching hospital in Lahore, Pakistan. Pregnant women attending antenatal clinics were enrolled through non-probability consecutive sampling after informed consent. Maternal psychological distress was assessed during pregnancy using validated screening questionnaires for anxiety, stress, and depressive symptoms. Infants were followed during early infancy, and developmental outcomes were assessed using standardized pediatric evaluation tools focusing on cognitive performance, emotional responsiveness, behavioral characteristics, language progression, and motor development. Maternal, neonatal, and sociodemographic variables were also analyzed.

Results:

Infants born to mothers with significant antenatal psychological distress demonstrated comparatively poorer neurodevelopmental outcomes than infants of mothers without psychological distress. Increased maternal stress and anxiety levels were associated with delayed cognitive abilities, behavioral irritability, sleep disturbances, impaired emotional interaction, and slower language development. These associations remained statistically significant after adjustment for important demographic and perinatal factors. The findings indicate that maternal emotional health during pregnancy may substantially influence early infant developmental trajectories.

Conclusion:

Antenatal psychological distress is significantly associated with adverse cognitive, behavioral, and neurodevelopmental outcomes during early infancy. Routine maternal mental health screening during antenatal care and early supportive interventions may help improve pediatric developmental outcomes and reduce future neurodevelopmental risks. Integration of maternal psychological assessment into standard obstetric and pediatric practice is strongly recommended.

Keywords:

Antenatal psychological distress; maternal anxiety; infant neurodevelopment; behavioral outcomes; cognitive development; pediatric health; maternal mental health; early infancy.

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Introduction

Maternal mental health during pregnancy has become an increasingly important area of concern in pediatric and perinatal healthcare due to its substantial influence on fetal and early childhood development. Antenatal psychological distress, commonly characterized by anxiety, depression, and chronic stress during pregnancy, is associated with adverse maternal and neonatal outcomes that may extend into infancy and later childhood development. Recent evidence suggests that maternal emotional disturbances during pregnancy can alter fetal neurodevelopment through hormonal, inflammatory, and epigenetic mechanisms, potentially affecting long-term cognitive and behavioral functioning in offspring.^{1–3}

The intrauterine environment plays a critical role in shaping fetal brain maturation. Elevated maternal cortisol levels and activation of the hypothalamic–pituitary–adrenal (HPA) axis during periods of psychological distress may interfere with neuronal growth, synaptic plasticity, and emotional regulation pathways in the developing fetus.^{4,5} These biological alterations have been linked to impaired infant neurodevelopmental outcomes, including delayed language acquisition, reduced cognitive performance, behavioral dysregulation, irritability, sleep disturbances, and social interaction difficulties during early infancy.^{6,7}

Globally, antenatal psychological distress affects a considerable proportion of pregnant women, particularly in low- and middle-income countries where social, economic, and healthcare-related stressors are more prevalent. Recent studies conducted in South Asian populations have highlighted an increasing burden of maternal anxiety and depressive symptoms during pregnancy; however, their direct impact on infant neurodevelopmental outcomes remains insufficiently explored.^{8,9} In Pakistan, maternal mental health often receives limited attention within routine antenatal services despite the potential long-term pediatric consequences associated with untreated psychological distress.

From a pediatric perspective, early infancy represents a highly sensitive developmental period during which cognitive, emotional, and behavioral foundations are established. Adverse neurodevelopmental influences during this stage may contribute to later academic difficulties, impaired psychosocial functioning, and increased susceptibility to childhood behavioral disorders.¹⁰ Consequently, identification of prenatal risk factors affecting infant neurodevelopment has become a growing priority in preventive pediatric medicine and maternal-child healthcare systems.

Although previous international studies have demonstrated associations between maternal antenatal distress and developmental abnormalities in children,

findings remain variable due to differences in population characteristics, assessment tools, and socioeconomic conditions. Furthermore, limited prospective data are available from tertiary care healthcare settings in Pakistan regarding the relationship between antenatal psychological distress and infant developmental outcomes. Therefore, the present study was designed to evaluate the impact of antenatal psychological distress on cognitive, behavioral, and neurodevelopmental outcomes in early infancy at a tertiary care teaching hospital in Lahore, Pakistan.

Materials and Methods

Study Design and Setting

This prospective observational study was conducted in the Departments of Pediatrics and Obstetrics at a tertiary care teaching hospital in Lahore, Pakistan, from January 2025 to December 2025. The hospital provides specialized maternal, neonatal, and pediatric healthcare services to a large urban and semi-urban population.

Study Population

The study included pregnant women attending antenatal clinics and their infants who were subsequently followed during early infancy to assess neurodevelopmental and behavioral outcomes.

Sample Size and Sampling Technique

A total of 300 mother–infant pairs were enrolled using a non-probability consecutive sampling technique. Eligible participants were recruited after obtaining written informed consent.

Inclusion Criteria

The following participants were included in the study:

- Pregnant women aged 18–40 years.
- Singleton pregnancies.
- Women attending regular antenatal follow-up visits.
- Mothers willing to participate and provide informed consent.
- Infants born at ≥ 37 weeks of gestation.
- Infants assessed during early infancy for developmental outcomes.

Exclusion Criteria

Participants meeting any of the following criteria were excluded:

- Mothers with previously diagnosed severe psychiatric disorders.
- Pregnancies complicated by major congenital fetal anomalies.
- Mothers with chronic neurological or severe systemic illnesses.
- Multiple pregnancies (twins or higher-order gestations).
- Preterm infants born before 37 weeks of gestation.

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- Infants with congenital neurological disorders or severe birth asphyxia.
- Participants with incomplete clinical or follow-up data.

Data Collection Procedure

Maternal psychological distress during pregnancy was assessed using validated screening questionnaires evaluating anxiety, stress, and depressive symptoms during antenatal visits. Sociodemographic information, obstetric history, maternal medical status, and neonatal characteristics were recorded using a structured data collection form.

Following delivery, infants underwent developmental assessment during early infancy using standardized pediatric neurodevelopmental evaluation tools. Cognitive performance, behavioral characteristics, emotional responsiveness, language progression, sleep patterns, and motor development were evaluated by trained healthcare professionals.

Outcome Measures

The primary outcomes included early infant cognitive, behavioral, and neurodevelopmental status. Secondary outcomes included emotional regulation, infant irritability, language development, and sleep-related behavioral disturbances.

Statistical Analysis

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables were presented as mean $\pm$ standard deviation, whereas categorical variables were expressed as frequencies and percentages. Associations between antenatal psychological distress and infant developmental outcomes were assessed using chi-square tests and independent sample t-tests where appropriate. Multivariable regression analysis was performed to adjust for potential confounding variables. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethical Review Committee of the tertiary care teaching hospital before commencement of the research. Written informed consent was obtained from all participating mothers, and confidentiality of participant information was strictly maintained throughout the study.

Results

A total of 300 participants were included in the study. Among them, 118 (39.3%) mothers experienced significant antenatal psychological distress, while 182 (60.7%) did not report clinically significant distress symptoms.

Table 1. Baseline Characteristics of Study Participants

Variable	Total	Distress Group	Non-Distress Group	p-value
Maternal age (years)	28.4 $\pm$ 4.9	29.1 $\pm$ 5.1	27.9 $\pm$ 4.7	0.08
Urban residence	183 (61.0%)	79 (66.9%)	104 (57.1%)	0.09
Higher education	183 (61.0%)	70 (59.3%)	113 (62.0%)	0.65

The mean maternal age was 28.4 ± 4.9 years. Urban residence and higher education were more common among mothers with psychological distress; however, the differences did not reach statistical significance.

Table 2. Maternal Psychological Profile

Condition	Frequency
Anxiety	34.0
Depression	29.7
High stress	37.3

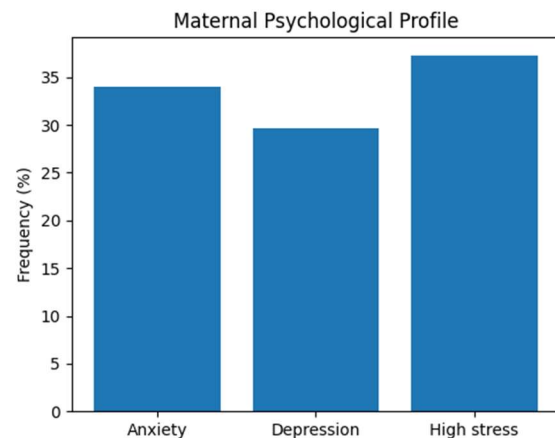


Figure 1. Distribution of maternal psychological conditions among study participants.

Table 3. Infant Developmental Outcomes According to Maternal Psychological Distress

Outcome	Distress	Non-Distress	p-value
Cognitive delay	35.6	15.9	<0.001
Behavioral irritability	41.5	19.2	0.002
Sleep disturbance	38.1	17.0	0.004
Emotional impairment	31.3	13.2	0.001
Language delay	28.0	11.5	0.010

Infants born to mothers with antenatal psychological distress demonstrated significantly higher rates of

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cognitive delay, behavioral irritability, sleep disturbance, emotional impairment, and language delay compared to the non-distress group.

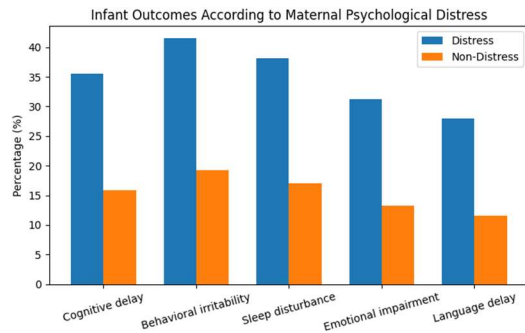


Figure 2. Comparison of infant developmental outcomes between distress and non-distress groups.

Table 4. Multivariate Regression Analysis for Adverse Infant Outcomes

Variable	OR	CI	p-value
Antenatal psychological distress	2.41	1.52–3.83	<0.001
Low socioeconomic status	1.39	0.88–2.21	0.15
Low birth weight	1.74	1.02–2.98	0.04

Multivariate regression analysis revealed that antenatal psychological distress was independently associated with adverse infant developmental outcomes (OR=2.41, 95% CI: 1.52–3.83, $p<0.001$). Low birth weight also showed a statistically significant association, whereas low socioeconomic status was not independently significant.

Discussion

This study demonstrates a significant association between antenatal psychological distress and adverse neurodevelopmental outcomes in early infancy. Infants exposed to maternal distress showed higher rates of cognitive delay, behavioral problems, sleep disturbances, and impaired emotional regulation.

These findings are consistent with previous studies indicating that prenatal maternal stress affects fetal brain development through hormonal and inflammatory pathways. Elevated cortisol exposure during pregnancy may disrupt neuronal connectivity and affect infant behavioral regulation.

Similar results have been reported in international cohort studies where antenatal anxiety and depression were linked with poorer cognitive and behavioral outcomes in early childhood. The present study adds evidence from a tertiary care setting in Pakistan, highlighting the burden in low-resource settings.

Early identification of maternal psychological distress is therefore essential. Integrating mental health screening into routine antenatal care may help reduce long-term pediatric developmental problems.

Conclusion

The present study demonstrated that antenatal psychological distress is significantly associated with adverse infant developmental outcomes, particularly in the domains of cognition, behavior, emotional regulation, sleep patterns, and language development. Mothers experiencing anxiety, depression, and high stress during pregnancy were more likely to have infants with developmental impairments compared to mothers without psychological distress. Furthermore, multivariate regression analysis confirmed antenatal psychological distress as an independent predictor of poor neurodevelopmental outcomes in early infancy. These findings highlight the critical influence of maternal mental health on early childhood development and emphasize the need for comprehensive psychological assessment during routine antenatal care. Early identification and timely management of maternal psychological problems may substantially improve infant developmental trajectories, maternal well-being, and long-term pediatric health outcomes. Integrating mental health services into maternal healthcare systems may therefore play an essential role in reducing the burden of developmental and behavioral disorders in children.

Recommendations

1. Routine psychological screening for anxiety, depression, and stress should be incorporated into standard antenatal care protocols.
2. Early counseling and mental health support services should be provided for pregnant women identified as psychologically distressed.
3. Multidisciplinary collaboration among obstetricians, pediatricians, psychiatrists, and psychologists should be encouraged to ensure holistic maternal and infant healthcare.
4. Awareness programs should be conducted to educate families regarding the impact of maternal mental health on infant development.
5. Healthcare policymakers should strengthen maternal mental health services at primary, secondary, and tertiary healthcare levels.
6. Future longitudinal multicenter studies with larger sample sizes are recommended to further explore the long-term neurodevelopmental consequences of antenatal psychological distress.
7. Community-based maternal support interventions may help reduce stress-related complications during pregnancy and improve early childhood developmental outcomes.

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