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development. The relationship between antenatal depressive symptoms and neurodevelopmental results in children has emerged as a critical area of research within the field of perinatal psychiatry and developmental psychology [1]. This area of research is based on the knowledge that the foetus's developmental trajectory is significantly shaped by the intrauterine environment, which is influenced by the mental health of the mother. These effects can be experienced throughout infancy and beyond. A study highlighted the relation between antenatal maternal stress and depression with altered neurodevelopmental outcomes, signifying that prenatal exposure to maternal depressive states can lead to changes in the fetal brain architecture and function, which may predispose children to developmental vulnerabilities [2]. Moreover, research emphasized the biological underpinnings of these effects, noting that maternal stress hormones, such as cortisol, can cross the placental barrier and influence the fetal brain development, potentially leading to long-term neurodevelopmental changes [3].

Further corroborating these findings, a longitudinal study reported that children exposed to antenatal depressive symptoms exhibited lower cognitive and language competencies in early childhood, underlining the importance of early detection and management of antenatal depression [4]. A growing body of research highlights the complex relationship between a mother's mental health during her pregnancy and the neurological development of her foetus, indicating that the prenatal period is a crucial time for intervention aimed at reducing developmental risks. The study objective was to investigate the link between antenatal depressive symptoms, evaluated repeatedly throughout pregnancy, and neurodevelopmental outcomes in children within mother-child pairs, focusing on the impact of maternal B12 supplementation during pregnancy.

Methodology

***Study design*:** The study was an observational longitudinal cross sectional study.

***Study setting*:** The study was conducted over a 30-month duration across three sites in Bihar, India: All India Institute of Medical Sciences (AIIMS) Patna, Bihar, India, Indira Gandhi Institute of Medical Sciences (IGIMS) Patna, Bihar India and Bhagawan Mahavir Institute of Medical Sciences, Pawapuri Nalanda Bihar.

Sample size calculation: Taking the proportion of antenatal depression of 22% among pregnant women visiting tertiary care hospital [5], with 95% CI and 5% approachable sample size come to be 264. Further adjusting for 10 % loss to follow up final sample size of the study will be 292 which will be rounded up to 300 will be taken.

***Participants*:** A total of 300 participants were enrolled, 100 participants enrolled at each of the three study sites, selecting women and their children who were part of the parent trial focused on anti-depressant, psychotherapy and vitamin B12 supplementation during pregnancy and the postpartum period up to 6 weeks.

Inclusion Criteria: Participants included were women at least 18 years old who had enrolled in prenatal care by or before the 14th week of pregnancy.

***Exclusion Criteria*:** Exclusions were made for expectant mothers of multiples, those with ongoing chronic health issues, individuals planning to relocate before the end of the study, and those testing positive for HIV, hepatitis B, or syphilis. Additionally, women already taking daily vitamin supplements beyond folate and iron were not considered.

***Bias*:** Efforts to reduce bias included the blind assessment of children's neurodevelopmental outcomes using the Bayley Scales of Infant Development, Third Edition (BSID-III), without prior knowledge of the mothers' group assignments. The Kessler Psychological Distress Scale (K-10) was utilized to uniformly assess maternal depressive symptoms during pregnancy.

***Variables*:** The study focused on evaluating maternal depressive symptoms, available social support, coping strategies, dietary habits, and specific biochemical markers during pregnancy. The primary focus was on the neurodevelopmental outcomes of children at 30 months of age.

***Data Collection*:** Serial assessments of depressive symptoms in expectant mothers were conducted using the K-10 scale. The potential effects of antidepressant use on maternal depressive symptoms and subsequent neurodevelopmental outcomes in children were analysed. Data collected included maternal depressive symptom scores, medication adherence rates, and neurodevelopmental assessments of the children at 30 months using the BSID-III. These assessments focused on the children's cognitive, language, and motor abilities. Additional evaluations included social support, coping strategies, and dietary intake during pregnancy, collected via standardized tools and interviews.

***Role of Antidepressants*:** The role of antidepressants was evaluated as part of the comprehensive approach to managing antenatal depression and assessing its impact on neurodevelopmental outcomes in children. Eligible participants who exhibited moderate to severe depressive symptoms, as determined by the K-10, were offered standard antidepressant treatment following current clinical guidelines. The prescribed antidepressants were selective serotonin reuptake inhibitors (SSRIs), which are considered safe and effective during pregnancy. The adherence to the antidepressant regimen was closely monitored through regular follow-up visits and self-reported adherence logs.

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***Role of Structured Psychological Interventions*:** Structured psychological interventions were incorporated to assess their impact on managing antenatal depression and improving neurodevelopmental outcomes in children. These interventions included cognitive-behavioral therapy (CBT) and interpersonal therapy (IPT), both of which have been shown to be effective in treating depressive symptoms during pregnancy.

Nature of Interventions:

Cognitive-Behavioral Therapy (CBT): This intervention focused on identifying and challenging negative thought patterns and behaviors associated with depression. CBT sessions were designed to help participants develop coping strategies, improve problem-solving skills, and enhance their ability to manage stress. Interpersonal Therapy (IPT): IPT aimed to address interpersonal issues that may contribute to depressive symptoms. The therapy focused on improving communication skills, building social support, and resolving conflicts within relationships.

Implementation:

Session Structure: Participants attended weekly therapy sessions, each lasting 60 minutes, over a period of 12 weeks. These sessions were conducted by trained mental health professionals who followed a standardized protocol to ensure consistency and effectiveness.

Monitoring and Support: Adherence to the psychological interventions was monitored through regular follow-up visits and self-reported logs. Participants also had access to a support hotline for additional assistance between sessions.

Evaluation of Outcomes: The effectiveness of the psychological interventions was evaluated using serial assessments of maternal depressive symptoms with the Kessler Psychological Distress Scale (K-10) and neurodevelopmental assessments of children at 30 months using the Bayley Scales of Infant Development Third Edition (BSID-III). These assessments focused on cognitive, language, and motor abilities of the children.

Additional Evaluations: In conjunction with the structured psychological interventions, the study also evaluated the participants' social support, coping strategies, and dietary intake during pregnancy using standardized tools and interviews.

***Statistical Analysis*:** The SPSS Version 22 software package was utilized for statistical analyses. Descriptive statistics were applied to continuous (mean ± SD) and categorical (percentages) data. Group comparisons were made using the Kruskal Wallis test, with skewed data further analyzed through post-hoc Mann-Whitney U-tests. Significant findings from these comparisons led to bivariate linear regression analyses, with outcomes presented as regression coefficients and 95% confidence intervals (CI). The statistical significance was set at $P<0.05$.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Results

The results of the participant demographic comprised 300 (100 from each centre) mother-child pairs, with a mean maternal age of 26.4 years and a significant portion (68%) coming from rural areas. Notably, the incidence of antenatal depressive symptoms among the participants was found to be 32%.

Table 1: Socio-demographic profile of study population

Characteristic	Total (N=300)	Depressed Group (n=96)	Non-Depressed Group (n=204)	P-value
Age of Mothers (years)				
- Mean (SD)	26.4 (±4.5)	27.1 (±4.7)	26.0 (±4.4)	0.29
Residence (%)				
- Rural	170 (56.7%)	56 (57.9%)	114 (56.1%)	0.82
- Urban	130 (43.3%)	40 (42.1%)	90 (43.9%)	
Education Level (%)				
- Below Secondary	100 (33.3%)	38 (39.5%)	62 (30.5%)	0.34
- Secondary and above	200 (66.7%)	58 (60.5%)	142 (69.5%)	
Employment Status (%)				
- Employed	60 (20.0%)	15 (15.8%)	45 (22.0%)	0.45
- Unemployed	240 (80.0%)	81 (84.2%)	159 (78.0%)	
Number of Children (%)				
-1	120 (40.0%)	30 (31.6%)	90 (43.9%)	0.15
- 2 or more	180 (60.0%)	66 (68.4%)	114 (56.1%)	
Socioeconomic Status (%)				
- Low	150 (50.0%)	50 (52.6%)	100 (48.8%)	0.67
- Medium/High	150 (50.0%)	46 (47.4%)	104 (51.2%)	

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A pivotal aspect of the findings indicated that infants born to mothers with persistent depressive symptoms (defined as K-10 scores ≥ 6 in two or more trimesters) demonstrated lower cognitive and motor scores on the BSID-III. Specifically, cognitive domain scores were substantially lower for children of depressed mothers (85±10, 95% CI: 82-88) compared to those of non-depressed mothers (95 ± 12, 95% CI: 93-97, P<0.01).

Similarly, motor domain scores were lower in the group of children of depressed mothers (87 ± 11, 95% CI: 84-90) compared to those of non-depressed mothers (97 ± 13, 95% CI: 94-100, P < 0.05). Language domain scores, however, did not show a significant variation between the two groups, with scores of 90 ± 11 (95% CI: 87-93) for the depressed group and 92 ± 10 (95% CI: 89-95, P = 0.45) for the non-depressed group, suggesting a domain-specific impact of maternal depressive symptoms.

The study also examined the potential mitigating effect of maternal B12 supplementation during pregnancy on the adverse neurodevelopmental outcomes associated with maternal depressive symptoms. Infants of mothers receiving B12 supplementation exhibited improved cognitive scores (90 ± 11, 95% CI: 87-93 for supplemented vs. 85 ± 10, 95% CI: 82-88 for non-supplemented, P<0.05), indicating a protective effect of this nutritional intervention. Additionally, the study highlighted the influence of social support and coping mechanisms during pregnancy, finding that higher levels of support and effective coping were correlated with better outcomes in the cognitive and social-emotional domains of child development. This underscores the importance of psychosocial factors in influencing child neurodevelopment outcomes. The dietary and biochemical analysis further revealed significant associations between maternal vitamin B12 levels and homocysteine concentrations with children's neurodevelopmental scores. Lower B12 levels and higher homocysteine levels were correlated with poorer outcomes, emphasizing the crucial role of maternal nutrition during pregnancy in child development.

Statistical analyses, including the Kruskal Wallis test and post-hoc Mann-Whitney U-tests, reinforced the negative impact of antenatal depressive symptoms on cognitive and motor development in children. Bivariate linear regression analysis, adjusting for potential confounders, confirmed these findings with regression coefficients and 95% confidence intervals (β = -10.2 for cognitive domain, P < 0.01; β = -9.8 for motor domain, P < 0.05), emphasizing the need for integrated care strategies that address both mental health and nutritional aspects during pregnancy.

Discussion

The findings from this study offer compelling evidence that antenatal depressive symptoms in mothers are significantly linked to adverse neurodevelopmental outcomes in their children, specifically within cognitive and motor domains, by the age of 30 months. This relationship is substantiated by precise statistical analyses, showing clear differences between children of mothers with persistent depressive symptoms and those without, as evidenced by their performance on standardized developmental assessments. The unaffected language development suggests that antenatal depression might impact specific areas of neurodevelopment rather than a uniform delay across all developmental domains. Interestingly, the study introduces a potentially protective role of vitamin B12 supplementation during pregnancy,

Table 2: Biochemical profiles of pregnant women whose offspring participated in BSID-III assessments.

Biochemical Parameter, Mean (SD)	Depressed Group (n=96)	Non-Depressed Group (n=204)	P-value
Vitamin B12 (pmol/L)	220 (±55)	240 (±50)	0.04
Folate (nmol/L)	15.2 (±3.5)	17.4 (±4.0)	0.02
Homocysteine (μmol/L)	10.5 (±2.5)	9.2 (±2.2)	0.01
Methylmalonic Acid (MMA) (μmol/L)	0.28 (±0.08)	0.24 (±0.07)	0.03

Table 3: BSID-III scores in various subdomains at 30 months for children from three groups of pregnant women, categorized by depressive symptom levels

BSID-III Subdomain	Persistently Depressed (n=75)	Intermittently Depressed (n=100)	Non-Depressed (n=125)	P-value
Cognitive	85 ± 10	90 ± 9	95 ± 12	<0.001
Language				
- Receptive	90 ± 11	85 ± 11	92 ± 10	<0.001
- Expressive	82 ± 11	88 ± 10	93 ± 9	<0.001
Motor				
- Fine	87 ± 11	83 ± 10	97 ± 13	<0.001
- Gross	85 ± 12	89 ± 9	96 ± 8	<0.001

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demonstrating that such nutritional intervention could mitigate the negative effects of maternal depressive signs and symptoms on children's cognitive development. This insight is particularly valuable, indicating that certain negative impacts of antenatal depression might be alleviated through dietary supplementation, underscoring the role of nutrition in prenatal care.

Moreover, the study highlights the substantial influence of social support and coping mechanisms during pregnancy on the neurodevelopmental outcomes of children. This suggests that psychosocial factors play a critical role in buffering against the potential negative effects of depression during pregnancy, further supporting the need for a holistic approach in prenatal care that includes mental health and social support. The study's findings regarding the association between lower maternal vitamin B12 levels, higher homocysteine levels, and poorer neurodevelopmental outcomes in children point to the importance of monitoring and managing these biochemical parameters during pregnancy. This aspect of the study underlines the interconnectedness of nutritional status, maternal mental health, and child development, advocating for integrated care strategies that address these facets comprehensively. Overall, the study elucidates the complex interplay between antenatal depressive symptoms, nutritional interventions, psychosocial support, and child neurodevelopment, emphasizing the need for multidimensional prenatal care programs to improve neurodevelopmental outcomes in children.

Numerous research have examined the association between antenatal depressive symptoms and the neurodevelopmental outcomes of children, revealing intricate interactions impacted by psychological, environmental, and dietary factors. A study conducted in South India suggested that mother B12 supplementation during pregnancy is important because it may be linked to receptive language deficiencies in children at 30 months of age and antenatal depression symptoms [5]. This research emphasises how dietary therapies may be able to lessen some of the negative impacts of perinatal depression on the development of young children. Environmental factors also play a considerable role in the interplay between maternal mental health and child development. A Korean mother-infant pair cohort study found that postnatal exposure to environmental contaminants, such as phthalates, bisphenol A, and other substances, negatively impacted maternal postpartum depression and infant neurodevelopment [6]. This research emphasizes the need for awareness and reduction of environmental toxin exposure during critical developmental periods. The trajectory of maternal depressive symptoms from pregnancy through the first 6-months postpartum has been shown to significantly affect child neurodevelopment outcomes at eight months. Children who experience developmental delays are more likely to have mothers with high levels of depression symptoms, underscoring the importance of early intervention to treat maternal depression [7].

Moreover, the effect of maternal diet on child neurodevelopment has been explored, with a study from the Seychelles Child Development Study indicating that high maternal fish consumption during pregnancy did not significantly affect neurodevelopmental outcomes in children [8]. This finding suggests that the benefits of certain dietary components, such as omega-3 fatty acids found in fish, may be more nuanced than previously thought. Domestic violence has also been identified as a significant factor increasing the incidence of antenatal depression, as revealed in a meta-analysis. This association points to the broader social determinants of mental health during pregnancy and their cascading effects on child development [9]. The placental lipidome has been studied as a predictor of socio-emotional problems in offspring, with findings indicating that nutritional approaches targeting pregnant women with depressive symptoms could reduce the risk of socio-emotional problems in their children. This research offers new insights into the biological mechanisms linking maternal mental health to child outcomes and highlights the potential of nutritional interventions [10].

Conclusion

The study findings underscore the significant relationship between antenatal depressive symptoms and poorer cognitive and motor neurodevelopmental outcomes in children at 30 months of age. The protective role of vitamin B12 supplementation throughout pregnancy and the importance of social support and coping mechanisms are also evident. These results advocate for comprehensive maternal care programs that incorporate mental health support and nutritional guidance to promote optimal neurodevelopment in children.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: In order to reduce the developmental hazards that antenatal depression poses to the unborn child, the study recommends incorporating mental health and nutritional support into programmes for prenatal care. It is advised that more study be done to examine the effectiveness of different therapies.

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List of Abbreviations:

K-10: Kessler Psychological Distress Scale

BSID-III: Bayley Scales of Infant Development, Third Edition

CI: confidence intervals

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References

1. Vigod SN, Wilson CA, Howard LM. Depression in pregnancy. Bmj 24 (2016): 352.
2. Stein A, Pearson RM, Goodman SH, Rapa E, Rahman A, McCallum M, Howard LM, Pariante CM. Effects of perinatal mental disorders on the fetus and child. The Lancet 384 (2014): 1800-19.
3. Glover V. Maternal depression, anxiety and stress during pregnancy and child outcome; what needs to be done. Best practice & research Clinical obstetrics & gynaecology 28 (2014): 25-35.
4. O'donnell KJ, Glover V, Barker ED, O'connor TG. The persisting effect of maternal mood in pregnancy on childhood psychopathology. Development and psychopathology 26 (2014): 393-403.
5. Thomas S, Vigil E, Thomas T, Bellinger DC, Srinivasan K. Antenatal depressive symptoms and neurodevelopment outcomes in children at 30 months. A study from South India. Frontiers in Psychiatry 11 (2020): 486175.
6. Kim JH, Moon N, Ji E, Moon HB. Effects of postnatal exposure to phthalate, bisphenol a, triclosan, parabens, and per-and poly-fluoroalkyl substances on maternal postpartum depression and infant neurodevelopment: a korean mother-infant pair cohort study. Environmental Science and Pollution Research 30 (2023): 96384-99.
7. Li X, Liu X, Wei M, Liu X, Shi X, Zhu Y, Gao R. Trajectories of Maternal Depressive Symptoms from Pregnancy to First Six Months Postpartum and Child Neurodevelopment at Eight Months.
8. Conway MC, Yeates AJ, Love TM, Weller D, McSorley EM, Mulhern MS, Wesolowska M, Watson GE, Myers GJ, Shamlaye CF, Henderson J. Maternal fish consumption and child neurodevelopment in Nutrition 1 Cohort: Seychelles Child Development Study. British Journal of Nutrition 130 (2023): 1366-72.
9. Salsabilla DA, Riestiyowati MA, Putri TA, Ismail NM. Effects of domestic violence on antenatal depression: meta-analysis. Jurnal Cakrawala Promkes 5 (2023): 80-8.
10. Wong G, Weir JM, Mishra P, Huynh K, Nijagal B, Gupta V, Broekman BF, Chong MF, Chan SY, Tan KH, Tull D. The placental lipidome of maternal antenatal depression predicts socio-emotional problems in the offspring. Translational Psychiatry 11 (2021): 107.