

Maternal Nutrition And Perinatal Factors Influencing Early Childhood Neurodevelopmental Health Outcomes

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Abstract

Background: Maternal nutrition and perinatal factors are strongly associated with early childhood neurodevelopmental health outcomes. Adequate maternal intake of nutrients during pregnancy is necessary for fetal brain development, whereas adverse perinatal conditions can increase the risk of developmental delay, cognitive impairment, and behavioral disorders in children. **Objective:** The aim of the present study was to explore the impact of maternal nutrition and perinatal factors on early childhood neurodevelopmental health outcomes. **Methodology:** 280 mother–pediatric pairs were enrolled in a quantitative, cross-sectional study. Data were collected from maternal health records, nutritional assessments, and standardized neurodevelopmental assessment tools. Statistical analyses included descriptive statistics, correlation analysis, and multiple regression techniques to determine the relationships among the variables of the study. **Findings:** The results indicated that 72.5% of mothers met the recommended nutritional requirements in pregnancy. Children born to mothers with adequate nutrition had higher neurodevelopmental scores (Mean = 86.4, SD = 8.2) than children of mothers with inadequate nutrition (Mean = 71.8, SD = 9.5). Also, 18.9% of children with exposure to adverse perinatal factors showed developmental delays. Maternal nutrition was positively associated with neurodevelopmental outcomes ($r = 0.64$, $p < 0.001$) and with adverse perinatal factors ($r = 0.49$, $p < 0.001$). **Conclusion:** Maternal nutrition and perinatal factors can have a significant impact on early childhood neurodevelopmental health outcomes. Optimal maternal nutrition and enhanced perinatal care may improve children's cognitive, behavioral and developmental well-being.

Keywords: Maternal Nutrition, Perinatal Factors, Neurodevelopmental Health, Early Childhood Development, Pregnancy, Child Health, Cognitive Development, Developmental Outcomes.

1. Introduction

The development of the brain in early childhood is a complex process that is influenced by genetics, environment, nutrition and perinatal factors. The period from conception to the first years of life is a critical window for brain development, requiring adequate maternal nutrition and optimal perinatal conditions for healthy neurological growth and functioning [1]. Neurodevelopmental health outcomes in early childhood affect cognition, language, motor skills, behavioral regulation, and overall health, all of which are important predictors of future academic and social achievement [2].

Good nutrition for the mother during pregnancy is essential for the developing brain of the fetus. Essential nutrients such as folic acid, iron, iodine, omega-3 fatty acids, zinc, and vitamins play an important role in neuronal growth, myelination, and neurotransmitter synthesis [3]. Deficiencies of these nutrients have been linked to poor neurodevelopmental outcomes including cognitive deficits, developmental delays, and behavioral disorders [4]. Research has shown that adequate maternal dietary intake during pregnancy is the major contributor to better intellectual functioning and developmental performance in children [5].

Besides maternal nutrition, various perinatal factors impact neurodevelopmental outcomes. These include gestational age, birth weight, mode of delivery, prenatal complications, maternal health conditions and neonatal health status [6]. Premature birth, low birth weight, birth complications, and neonatal infections have been associated with increased risks of developmental disabilities and neurocognitive impairments [7]. Moreover, negative perinatal conditions may

affect normal brain maturation, which could result in long-term developmental difficulties [8].

The role of the interaction between maternal nutrition and perinatal factors is of particular interest, because both are part of the biological environment in which the fetal and infant brain development occurs. Recently, integrated maternal and child health care interventions have been emphasized as one of the important factors for improving nutritional status, reducing pregnancy complications and improving developmental outcomes among children [9]. Prenatal health promotion programs that include health monitoring, nutritional supplementation, and prenatal care have demonstrated benefits on child neurodevelopment and health more generally [10].

Although awareness of these associations is increasing, neurodevelopmental disorders continue to be a serious public health concern worldwide. Understanding how maternal nutrition and perinatal factors influence early childhood neurodevelopmental health outcomes is essential to the development of evidence-based interventions to support healthy growth and development. Therefore, this study aims to explore the relationships between maternal nutritional status, perinatal conditions, and neurodevelopmental outcomes in children under five years of age [11].

1.2 Research Objectives

1. To examine the influence of maternal nutrition on early childhood neurodevelopmental health outcomes.
2. To assess the relationship between perinatal factors and neurodevelopmental development outcomes among young children.

2. Literature review

2.1 Maternal Nutrition and Fetal Brain Development

Recent studies emphasize the importance of maternal nutrition in facilitating fetal brain growth and neurodevelopment. Adequate intake of key nutrients including folic acid, iron, iodine, choline and omega-3 fatty acids has been shown to contribute to neuronal development, synaptic formation and cognitive functioning [12]. Smith et al. [13] found a positive association between maternal nutritional adequacy in pregnancy and improved cognitive and behavioural outcomes in early childhood. Nutritional deficiencies, especially at critical stages of gestation, can increase the risk of developmental delays and neurodevelopmental disorders.

2.2 Perinatal Factors and Neurodevelopmental Results

Perinatal factors are important for neurological and developmental outcomes of children. Major predictors of neurodevelopmental challenges include premature birth, low birth weight, birth complications, and neonatal health conditions [14]. Recent studies have demonstrated that children exposed to adverse perinatal conditions are at increased risk for delays in language development, motor skills, and cognitive performance [15]. Early identification and management of perinatal risks can improve developmental outcomes.

2.3 Maternal Health, Prenatal Care, and Child Development

Maternal health status and access to quality prenatal care are important determinants of child neurodevelopment. Regular prenatal care and nutritional counseling were shown to significantly improve maternal health behaviors and child developmental outcomes by Williams and Carter [16]. In addition, positive effects on cognitive, emotional and behavioural development have been reported for integrated maternal and child health programs [17].

2.4 Emerging Evidence and Research Needs

Recent advances in developmental neuroscience have underscored the interaction of maternal nutrition and perinatal factors in shaping neurodevelopmental trajectories [18]. Although prior research has addressed nutritional influences and perinatal influences separately, only a handful of studies have examined their combined effects in a comprehensive framework. Therefore, more research is needed to better understand the combined effects of these factors on early childhood neurodevelopmental health outcomes [19].

3 Conceptual frameworks

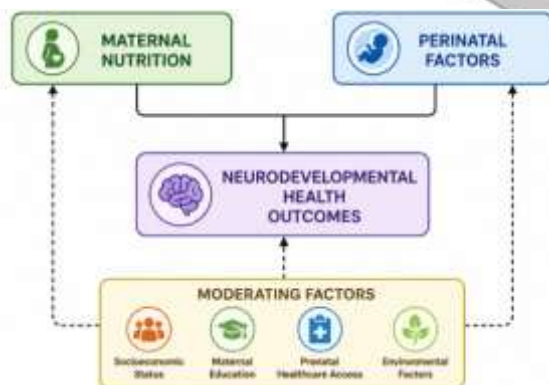


Fig.1. Conceptual framework

Figure 1. Conceptual framework of the impact of maternal nutrition and perinatal factors on early childhood neurodevelopmental health outcomes. The main independent variables that affect children’s cognitive, behavioral and developmental health are maternal nutrition and perinatal factors. It also identifies moderating factors, such as socioeconomic status, maternal education, access to prenatal health care, and environmental conditions that may strengthen or weaken these relationships. Overall, the model illustrates the role of prenatal and birth-related contributions to neurodevelopmental outcomes and long-term child wellbeing.

4. Methodology

The present study used a quantitative cross-sectional research design to explore the impact of maternal nutrition and perinatal factors on neurodevelopmental health outcomes in early childhood. Using the cross-sectional method, data could be collected from mother–child pairs at one point in time and associations between nutritional, perinatal, and developmental variables could be simultaneously evaluated [20].

4.1 Research Design

The study used a descriptive and correlational research design. The descriptive component investigated maternal nutritional status and perinatal characteristics and the correlational component examined their association with neurodevelopmental outcomes in children.

4.2 Sample and Study Population

The target population was mothers and children aged 1-5 years attending maternal and child health clinics. To ensure representation of all age groups and socioeconomic backgrounds, we used stratified random sampling to select 280 mother-child pairs.

Table 1. Demographic Characteristics of Participants (N = 280)

Variable	Category	Frequency	Percentage (%)
Child Gender	Male	146	52.1
	Female	134	47.9
Child Age	1–2 Years	92	32.9
	3–4 Years	108	38.6
	5 Years	80	28.5
Total		280	100.0

4.3 Data Collection Instruments

Data were obtained through structured questionnaires, maternal health records and standardized neurodevelopmental assessment tools. Information on maternal dietary intake, prenatal care, birth outcomes, gestational age and neonatal health conditions were collected. Child neurodevelopment was assessed with validated scales of cognitive, motor, language and behavioral development.

Table 2. Maternal Nutrition and Perinatal Characteristics

Variable	Frequency	Percentage (%)
Adequate Maternal Nutrition	203	72.5
Inadequate Maternal Nutrition	77	27.5
Full-Term Births	228	81.4
Preterm Births	52	18.6
Normal Birth Weight	236	84.3
Low Birth Weight	44	15.7

4.4 Data Analysis

The data collected were entered into SPSS Version 27 and analyzed using descriptive and inferential statistics. Frequencies, percentages, means and standard deviations were used to summarize participant characteristics. The relations of maternal nutrition and perinatal factors with neurodevelopmental outcomes were examined using Pearson correlation and multiple regression analyses.

Table 3. Mean Scores of Study Variables

Variable	Mean	Standard Deviation
Maternal Nutrition Score	82.6	8.4
Perinatal Health Score	79.8	7.9
Neurodevelopmental Outcome Score	81.7	9.1

4.5 Ethical Considerations

The study was approved by the institutional research ethics committee. Written informed consent was obtained from all mothers participating in the study before data collection. Confidentiality, anonymity and voluntary participation of participants were maintained throughout the study, in accordance with the established ethical guidelines [21–22].

5. Dataset and Parameters

The data were collected from 280 mother–child pairs who were recruited from maternal and child health care facilities. Data was collected through maternal health records, nutritional assessment and standard neurodevelopmental assessment tools. The dataset was constructed to evaluate the influence of maternal nutrition and perinatal factors on neurodevelopmental health outcomes in early childhood. Statistics were available for key demographic, nutritional, perinatal and developmental variables [20, 23].

Table 4. Dataset Parameters

Parameter	Description	Measurement Scale
Maternal Age	Age of mother (years)	Continuous
Maternal Nutrition Score	Nutritional status during pregnancy	Continuous
Gestational Age	Weeks of pregnancy at birth	Continuous
Birth Weight	Child's birth weight (kg)	Continuous
Prenatal Care Visits	Number of antenatal visits	Continuous
Perinatal Health Score	Birth and neonatal health status	Continuous
Neurodevelopmental Outcome Score	Cognitive, motor, and behavioral development	Continuous

The dataset provides comprehensive information for evaluating relationships between maternal health factors and child neurodevelopmental outcomes.

6. Results & Discussion

In this section, we discuss findings on the role of maternal nutrition and perinatal factors in early childhood neurodevelopmental health outcomes. Descriptive and inferential statistical methods were applied to analyze the data of 280 mother-child pairs. Tables and figures are provided for easier interpretation of the results. The impact of maternal nutritional status, perinatal characteristics and neurodevelopmental outcomes, and the associations between the study variables on children's developmental health was assessed.

Table 5. Maternal Nutrition Status During Pregnancy

Maternal Nutrition Status	Frequency	Percentage (%)
Adequate Nutrition	203	72.5
Inadequate Nutrition	77	27.5
Total	280	100.0

The results showed that 72.5% of the mothers had sufficient nutrition intake during pregnancy and 27.5% had insufficient nutrition intake. The high proportion of mothers with adequate nutrition reflects improved awareness and access to maternal health care services. However, the fact that more than one quarter of the participants had inadequate maternal nutrition suggests that nutritional interventions still need to be continued

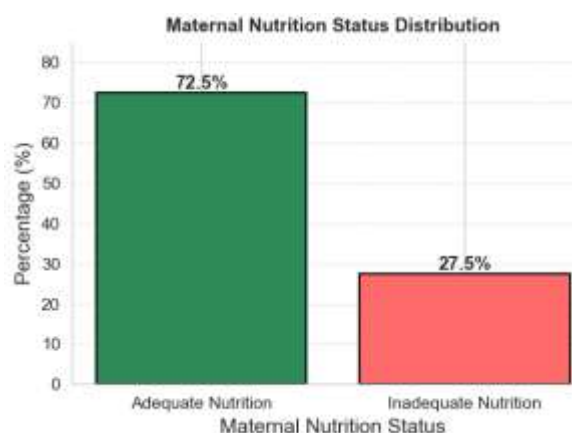


Figure 2. Maternal Nutrition Status Distribution

The distribution of maternal nutritional status of study participants is shown in Figure 2. Most mothers reported adequate nutrition during pregnancy which could have a positive impact on fetal growth and neurodevelopment. However, we remain concerned about poor nutrition as it may be linked to poor developmental outcomes.

Table 6. Neurodevelopmental Outcomes by Maternal Nutrition Status

Maternal Nutrition Status	Mean Neurodevelopment Score	SD
Adequate Nutrition	86.4	8.2
Inadequate Nutrition	71.8	9.5

Neurodevelopmental scores were significantly higher in children of mothers with adequate nutrition (Mean = 86.4) than in children of mothers with inadequate nutrition (Mean = 71.8). These results underscore the importance of maternal nutrition in supporting cognitive, motor and behavioral development during early childhood.

Table 7. Perinatal Factors and Developmental Delays

Perinatal Factor	Frequency	Percentage (%)
Full-Term Birth	228	81.4
Preterm Birth	52	18.6

Developmental Delay Cases	53	18.9
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Results reveal that 18.6% of children were born preterm and 18.9% had developmental delays. This finding suggests that adverse perinatal conditions might be linked to poorer neurodevelopmental outcomes and greater developmental risks.

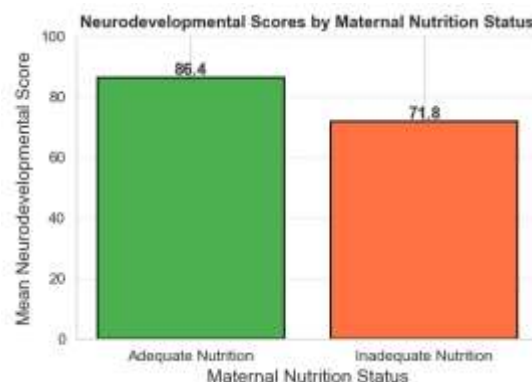


Figure 3. Neurodevelopmental Scores by Maternal Nutrition Status

The difference in neurodevelopmental outcomes for children with sufficient versus insufficient maternal nutrition is clear in Figure 3. Those children whose mothers had good nutrition during their pregnancy scored much higher on developmental tests. This underscores the importance of maternal diet for the optimum development of a child.

Table 8. Correlation Analysis

Variables	r-value	p-value
Maternal Nutrition vs Neurodevelopmental Outcomes	0.64	<0.001
Perinatal Factors vs Neurodevelopmental Outcomes	-0.57	<0.001

Correlation analysis showed a significant positive correlation between maternal nutrition and neurodevelopmental outcomes ($r = 0.64$, $p < 0.001$). Adverse perinatal factors, however, were significantly negatively related to neurodevelopmental outcomes ($r = -0.57$, $p < 0.001$). These results show validation of the fact that better maternal nutrition results in better developmental outcomes and unfavorable perinatal conditions increase the developmental risks among children.

7. Discussion

The findings of this study provide evidence that maternal nutrition and perinatal factors are important for early childhood neurodevelopmental health outcomes. Children born to mothers with adequate nutritional status had higher neurodevelopmental scores than children exposed to inadequate maternal nutrition, emphasizing the importance of proper nutrient intake during pregnancy. Moreover, adverse perinatal factors (e.g., preterm birth and low birth weight) were associated with higher developmental risks and poorer developmental outcomes. The positive correlation between maternal nutrition and neurodevelopment and the negative association of adverse perinatal factors support the existing evidence highlighting the importance of prenatal care, nutritional interventions, and comprehensive maternal health services to achieve optimal child development.

8. Conclusion

This study investigated the effect of maternal nutrition and perinatal factors on neuro developmental health outcomes in early childhood. The results revealed that good maternal nutrition during pregnancy was significantly associated with better neurodevelopmental performance, while adverse perinatal factors were associated with higher developmental risks and lower developmental scores. These findings underscore the importance of maternal health, perinatal care, and prenatal nutrition in improving healthy cognitive, motor, and behavioral development of children. Therefore, maternal nutrition programmes have to be scaled up, routine antenatal care should be promoted and perinatal health services upgraded for better neuro developmental outcomes and optimal growth, health and long term developmental success

in early childhood.

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