International Research Journal of Education and Technology

Peer Reviewed Journal, **ISSN 2581-7795**

# A STUDY TO ANALYZE THE RELATIONSHIP BETWEEN MATERNAL NUTRITION AND BIRTH OUTCOMES

***Rishish Sharma****

*Research Scholar*

*Department of Zoology*

*Major S.D. Singh University Farrukhabad, U.P.*

***Dr. Jaivir Singh*****

*Professor*

*Department of Zoology*

*Major S.D. Singh University Farrukhabad, U.P.*

## ABSTRACT

*In this review, the authors summarize current knowledge on maternal nutritional requirements during pregnancy, with a focus on the nutrients that have been most commonly investigated in association with birth outcomes. Data sourcing and extraction included searches of the primary resources establishing maternal nutrient requirements during pregnancy (e.g., Dietary Reference Intakes), and searches of Medline for "maternal nutrition"/[specific nutrient of interest] and "birth/pregnancy outcomes," focusing mainly on the less extensively reviewed evidence from observational studies of maternal dietary intake and birth outcomes. The authors used a conceptual framework which took both primary and secondary factors (e.g., baseline maternal nutritional status, socioeconomic status of the study populations, timing and methods of assessing maternal nutritional variables) into account when interpreting study findings. The authors conclude that maternal nutrition is a modifiable risk factor of public health importance that can be integrated into efforts to prevent adverse birth outcomes, particularly among economically developing/low-income populations.*

***Keywords:*** *maternal; birth; outcomes*

# I. INTRODUCTION

The health of mothers and children is significantly influenced by nutrition. Negative birth outcomes have been linked to poor maternal nutritional status; however, this relationship is complicated and depends on a wide range of physiological, socioeconomic, and demographic factors that fluctuate greatly among populations (King & Sachet, 2000). A foundation for creating dietary interventions that would enhance birth outcomes and long-term quality of life while lowering mortality, morbidity, and medical expenses may be found in an understanding of the relationship between maternal nutrition and birth outcomes. Even though experimental animal studies have clearly shown the importance of maternal nutrition to fetal development and birth outcomes, human studies have produced much less consistent results, partly because of secondary factors that vary from study to study (e.g., baseline maternal nutritional status, socioeconomic status (SES) of the study population, timing, and methods of assessing or manipulating maternal nutritional variables). Furthermore, the majority of research and literature reviews pertaining to maternal nutrition and birth outcomes have tackled the problem by examining individual nutrients separately. On the one hand, this is required for a thorough analysis of the intricate problems at hand. However, research that address and integrate the larger picture of various nutrient intakes or deficiencies are lacking, and nutrient deficiencies are typically observed in low-SES communities, where they are more likely to involve several deficiencies rather than single deficiencies (Ramachandran, 2002). Our goal in this review is to present a comprehensive multinutrient and multifactorial summary of the research on the relationship between maternal nutrition and birth outcomes. We review research on the nutrients and nutrient combinations that have been most frequently examined in relation to birth outcomes, including energy, protein, essential fatty acids (particularly omega-3 fatty acids), iron, folate, and multinutrient supplements. We also provide an overview of the current state of knowledge regarding maternal nutritional requirements during pregnancy. Due to space constraints, some nutrients—such as magnesium, zinc, calcium, and vitamin C—that have been linked to birth and pregnancy outcomes but for which there is less data are not included (Kramer & Kakuma, 2003).

Despite the topic's wide scope, we concentrate our attention to the three main poor birth outcomes: intrauterine growth restriction (IUGR), preterm birth, and low birth weight. According to Peña-

Rosas and Viteri (2009), these unfavorable birth outcomes are the main causes of neonatal mortality for children born without congenital defects. They also frequently lead to both immediate and long-term health issues and disabilities (Makrides et al. 2006), including a potential risk of chronic disease as an adult (Szajewska et al. 2006). Furthermore, they may be changeable through nutritional treatments and have been thoroughly studied in relation to nutritional etiology and processes. We do not address other adverse birth outcomes (e.g., congenital anomalies) that have been linked to maternal nutrition and have been thoroughly reviewed in the literature (Shah & Ohlsson, 2009), nor pregnancy complications (e.g., preeclampsia and gestational diabetes) (Haider & Bhutta, 2006), which are outside the purview of this review as we have defined it.

### 1.1 Research objectives

- To evaluate the relationship between maternal nutrition and birth outcomes.

## II. ADVERSE BIRTH OUTCOMES AND THEIR CONSEQUENCES

Low birth weight, preterm birth, and IUGR are the poor birth outcomes discussed in this study. These conditions can have long-term effects on development, quality of life, and medical expenses. Premature delivery, intrauterine growth failure or disruption, or a combination of the two can cause low birth weight, which is defined as a birth weight of less than 2,500 g (Cogswell et al., 2003). According to Christian et al. (2003), low birth weight is a significant secondary factor in 40–80% of neonatal deaths, with 98% of these occurring in underdeveloped nations. Low birth weight is closely linked to prenatal morbidity and an elevated risk of long-term impairment in both industrialized and developing nations (Allen, 2005). The primary underlying cause of infant death among newborns with nonlethal congenital abnormalities is preterm delivery, which is defined as a gestational age shorter than 37 completed weeks. Preterm birth also significantly increases the prevalence of low birth weight (Scholl, 2005). Low birth weight and preterm infants have very expensive postpartum hospitalization and treatment expenditures. The average neonatal hospitalization expenditures per low-birth-weight and preterm infant increase exponentially as birth weight and gestational age at delivery fall, according to studies done in nations with highly developed medical systems (Jasienska, 2009). In one large population-based study in California,

the total hospitalization costs for the 266 infants weighing 500–750 g during the neonatal period (first 4 weeks of life) were almost the same (~$60,000,000) as the total hospitalization costs for the 48,610 infants weighing 2,750–3,000 g, a group that was more than 182 times larger (Selling et al. 2006). Low-birthweight and preterm infants continue to have hospitalization expenditures that are 4–10 times greater than those of normal-birth-weight and term infants during the first ten years of life (Nafee et al., 2008). Furthermore, children born preterm or low birth weight incur 2–10 times the expenses of physical, educational, and social developmental services compared to their term and normal-birth-weight counterparts (Fairley & Leyland, 2006). In the short term, IUGR increases the risk of perinatal and infant mortality and morbidity; in the long term, it increases the risk of disorders or disruptions of child growth and development, such as learning disabilities, mental retardation, neurologic disorders, and childhood psychiatric disorders (Waterland & Jirtle, 2004). According to research, babies that are born weighing less than the 10th percentile for their gestational age are considered tiny for gestational age and are more likely to die as newborns, even if they are born at term (Jansen et al., 2009). Many major adult diseases, including type 2 diabetes, hypertension, and coronary heart disease, are thought to have their roots in impaired intrauterine growth and development. This is especially true when combined with rapid or excessive growth/weight gain in childhood or adulthood, and it may even have an impact on subsequent generations (Kramer et al., 2000). Animal research has clearly demonstrated the physiologic plausibility of this theory; nevertheless, the majority of human studies have been observational and are therefore unsuitable for making causal conclusions. Despite the fact that very few studies were carried out in non-Western, developing/transitional populations, a review of the evidence supporting the developmental origins of hypertension reveals a fairly consistent association between fetal undernutrition (as indicated by low birth weight) and an increased risk of adult hypertension.

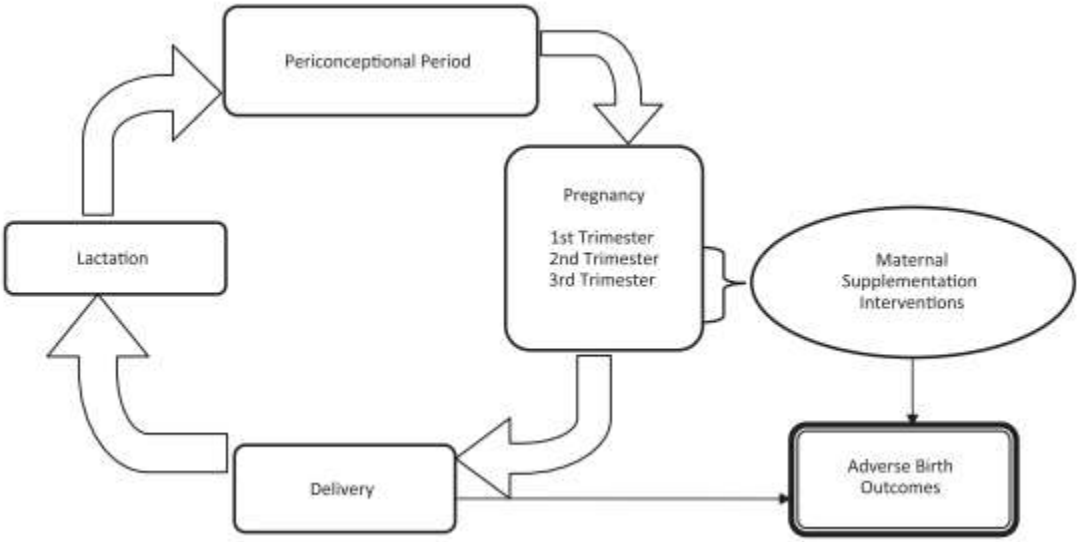


**Figure 1:** Design of most clinical trials evaluating associations between maternal nutrition and adverse birth outcomes (preterm birth, low birth weight, and/or intrauterine growth restriction) within the context of the complete reproductive cycle.

## III. CONCEPTUAL MODELS FOR STUDYING THE MATERNAL NUTRITION–ADVERSE BIRTH OUTCOME ASSOCIATION

The presumptions that underlie research on maternal nutrition and birth outcomes are frequently established by study design and feasibility and may not be specifically looked at or explored. After taking a quick look at these underlying presumptions, we will provide a conceptual framework for investigating the relationship between maternal nutrition and birth outcomes and analyzing study findings. When it comes to evidence-based medical treatment, well-designed RCT results are typically regarded as the highest level of evidence since they are the only kind of study from which causal conclusions may be drawn without raising questions regarding study group comparability. However, because it is not practical to conduct dietary intervention trials from baseline to a health/disease endpoint (which could take decades), the use of RCTs to investigate nutrition and the majority of health outcomes is limited. The study of maternal nutrition and birth outcomes has

been one of the most popular applications of RCTs in nutrition research since the "outcome" happens in a predictable and manageable amount of time. With very few exceptions, these RCTs evaluate the effects of a multinutrient supplement or modify the intake of one or two nutrients during one (or, more frequently, a portion of one) pregnancy (Figure 1). The question of whether maternal nutrition influences or can be altered to improve unfavorable birth outcomes has been the subject of in-depth assessments of the data from RCTs (Torres-Arreola et al., 2005). Meta-analyses, which combine results from a variety of studies with different baseline population characteristics and supplementation protocols with different starting points, durations, and amounts/formulations, are used in the majority of RCT reviews. This makes it more difficult to interpret the results. Table 1 shows the ranges of populations and supplement timing, duration, and dosage that are covered by the reviews of RCTs for the nutrients and birth outcomes of interest in this paper. By grouping subgroup analyses according to broad categories such as gestational age, baseline nutritional or risk status at trial entrance, type/amount of supplement use, etc., several of the more recent Cochrane studies have attempted to account for or lessen the impact of variation within these parameters. Nonetheless, it is still possible to mask potentially significant design variations that could provide disparate results. The group receiving supplements in one study that started iron supplementation very early in pregnancy (mean gestational age of 11 weeks at trial entry) showed significantly lower rates of low birth weight, for instance, according to a Cochrane meta-analysis of the effect of iron supplementation on rates of low birth weight. However, this effect was obscured in the meta-analysis of all other trials, including the subanalysis of trials that started at less than 20 weeks of gestational age. Similarly, a trial from a developing nation showed a substantial decrease in low birth weight when iron-folate supplementation was evaluated in relation to low birth weight (Finch, 2003). However, this impact was negated in the meta-analysis that included one additional trial from an industrialized nation.

An increasing amount of data suggests that the second to third trimester, which is often the time frame studied in RCTs, may not adequately capture significant nutrition-related effects on birth outcomes. Environmental and socioeconomic factors can reduce the effect of maternal nutrition on birth outcomes in a number of ways. For instance, a few months of supplementation during a single pregnancy cannot cure chronic undernutrition or various nutritional deficiencies caused by

SES levels that affect the quality of habitual and prenatal dietary consumption. Maternal age at childbearing onset, the duration of the interpregnancy period, and the length of the complete reproductive cycle, including lactation, are all variables that can be influenced by cultural and environmental factors. Reproductive outcomes may also be impacted by life-cycle and intergenerational factors, such as the mother's growth and nutrition as a child and the environment she encountered within the womb. The indirect relationship between maternal and fetal nutrition, which is mediated by the mother's habitual dietary intake, her intermediate metabolism, and her endocrine status, as well as the distribution of nutrients among storage, use, and circulation, the ability of circulating transport proteins, and cardiovascular adaptations to pregnancy that affect uterine blood flow, further complicates the relationship between maternal nutrition measures and birth outcomes. Additionally, the effects of maternal nutritional deficits are expected to vary according on the stage of fetal development at which they occur. Nutritional damages that take place at the very first stages of embryogenesis are crucial for subsequent fetal growth and birth outcomes, according to a variety of observational human research and experimental animal studies (Kamau-Mbuthia & Elmadfa, 2007). Animal research shows that throughout the peri-implantation and rapid placental development stages, maternal dietary nutrient deficiencies—specifically, protein and micronutrient deficiencies—have the greatest impact on fetal growth. Therefore, instead of addressing diet alone during pregnancy, researchers should start examining maternal nutritional status as a continuum that impacts the health of the mother, fetus, and newborn during the peri-conceptional, pregnancy, and breastfeeding phases. When and how maternal food intake is measured, when interventions are started, and how the findings are subsequently interpreted are all significantly impacted by this method.

## IV. RELATIONSHIP BETWEEN MATERNAL NUTRITION AND BIRTH OUTCOMES

The development and survival of the fetus as well as the health of the mother are both impacted by maternal nutrition, which is a major factor in determining birth outcomes. For baby growth, brain development, and the avoidance of delivery problems, adequate nutrition is crucial both

before and during pregnancy. Conversely, low birth weight, preterm birth, intrauterine growth restriction (IUGR), and neonatal death are all strongly associated with poor maternal nutrition.

Calorie and nutrient intake is one of the most crucial elements of maternal nutrition. A woman's nutritional needs rise throughout pregnancy in order to support the developing fetus and her own physiological changes. The three macronutrients—fats, proteins, and carbohydrates—are essential for the development of fetal tissue and give off energy. In particular, protein is essential for the development of the placenta, fetal tissues, and maternal blood volume. Equally significant are micronutrients including calcium, iodine, iron, folic acid, and vitamins A, D, and B12. For instance, maternal anemia, which is linked to a higher risk of preterm delivery and low birth weight, might result from iron deficiency. Neural tube abnormalities in neonates, including spina bifida and anencephaly, have been directly associated with folic acid deficiency (Morgen et al., 2008).

Mother malnutrition or undernutrition is still a serious public health issue, especially in low- and middle-income nations. Small for gestational age (SGA) babies are more likely to be born to pregnant women who are underweight or who do not gain enough weight throughout pregnancy. Later in childhood, these babies are more likely to experience infections, developmental problems, and chronic illnesses. On the other hand, excessive weight gain and malnutrition in mothers can also be troublesome since they raise the risk of gestational diabetes, hypertension, and delivery problems like cesarean sections. Macrosomia, or babies born much larger than typical, can also result from these diseases. This might make delivery more difficult and raise the possibility of birth complications.

Pregnancy outcomes are also influenced by maternal diet prior to conception. Women who are underweight, obese, or experiencing vitamin shortages at the start of their pregnancy may already be more vulnerable to difficulties. Thus, nutrition counseling and preconception care are becoming more widely acknowledged as critical measures in enhancing the health of mothers and children (Kramer et al., 2000).

Maternal nutrition is frequently impacted by socioeconomic variables; inadequate dietary intake is impeded by poverty, food insecurity, and limited access to healthcare facilities. Deficits may also result from culturally imposed food restrictions during pregnancy. When extensively used, public health initiatives including food fortification programs, iron and folic acid supplements, and nutrition education have been shown to improve birth outcomes. There is a complicated and nuanced relationship between maternal nutrition and birth outcomes. A crucial tactic for enhancing the health of the mother and the infant's survival, growth, and development is to make sure the mother is getting the best nutrition possible both before and during pregnancy. To guarantee that women of reproductive age have access to the nourishment and assistance they require to give birth to healthy infants, policymakers, healthcare professionals, and communities must collaborate (Finch, 2003).

## V. CONCLUSION

The findings of this study clearly underscore the strong and multifaceted relationship between maternal nutrition and birth outcomes. Adequate nutrition during the preconception and prenatal periods is essential for ensuring optimal fetal growth, minimizing the risk of pregnancy-related complications, and promoting the long-term health of both mother and child. The study highlights that both undernutrition and overnutrition among pregnant women are significant risk factors for adverse birth outcomes, including low birth weight, preterm birth, intrauterine growth restriction (IUGR), and neonatal mortality.

Key nutritional components—such as sufficient intake of calories, proteins, iron, folic acid, calcium, and essential vitamins—play critical roles in fetal development and maternal well-being. Deficiencies in these nutrients can lead to preventable complications such as maternal anemia, neural tube defects, gestational hypertension, and compromised immunity in both the mother and infant. On the other hand, excessive intake and poor dietary quality can contribute to maternal obesity, gestational diabetes, and complications during delivery, as well as increase the risk of long-term metabolic disorders in the child.

The study also emphasizes that the nutritional status of a woman before conception is as important as her dietary intake during pregnancy. Women entering pregnancy in a state of nutritional deficiency or excess are already at a higher risk of complications. Therefore, early nutritional interventions, including public health initiatives aimed at education, supplementation, and food security, are essential for improving birth outcomes.

Furthermore, this study sheds light on the impact of socioeconomic, cultural, and healthcare access factors that shape maternal nutrition. It reinforces the need for multi-level strategies involving community awareness, government policies, and healthcare provider engagement to ensure pregnant women receive adequate nutrition and support.

In conclusion, improving maternal nutrition must be a public health priority to reduce preventable complications during pregnancy and to foster healthier generations. Investing in maternal nutrition is not only a step toward healthier pregnancies but also a crucial foundation for the overall development and well-being of future populations.

## REFERENCES


- King JC, Sachet P. Maternal nutrition: new developments and implications [editorial]. Am J Clin Nutr. 2000;71(5 suppl): 1217S.
- Ramachandran P. Maternal nutrition—effect on fetal growth and outcome of pregnancy. Nutr Rev. 2002;60(5):S26–S34.
- Kramer MS, Kakuma R. Energy and protein intake in pregnancy [electronic article]. Cochrane Database Syst Rev. 2003;(4):CD000032.
- Pen˜a-Rosas JP, Viteri FE. Effects and safety of preventive oral iron or ironþfolic acid supplementation for women during pregnancy [electronic article]. Cochrane Database Syst Rev. 2009;(4):CD004736.
- Makrides M, Duley L, Olsen SF. Marine oil, and other prostaglandin precursor, supplementation for pregnancy uncomplicated by pre-eclampsia or intrauterine growth restriction [electronic article]. Cochrane Database Syst Rev. 2006;(3):CD003402.
- Szajewska H, Horvath A, Koletzko B. Effect of n-3 longchain polyunsaturated fatty acid supplementation of women with low-risk pregnancies on pregnancy outcomes and growth measures at birth: a meta-analysis of randomized controlled trials. Am J Clin Nutr. 2006;83(6):1337–1344.
- Haider BA, Bhutta ZA. Multiple-micronutrient supplementation for women during pregnancy [electronic article]. Cochrane Database Syst Rev. 2006;(4):CD004905.
- Shah PS, Ohlsson A. Knowledge Synthesis Group on Determinants of Low Birth Weight and Preterm Births. Effects of prenatal multimicronutrient supplementation on pregnancy outcomes: a meta-analysis. CMAJ. 2009;180(12): E99–E108.
- Cogswell ME, Parvanta I, Ickes L, et al. Iron supplementation during pregnancy, anemia, and birth weight: a randomized controlled trial. Am J Clin Nutr. 2003;78(4):773–781.
- Christian P, Khatry SK, Katz J, et al. Effects of alternative maternal micronutrient supplements on low birth weight in rural Nepal: double blind randomised community trial [electronic article]. BMJ. 2003;326(7389):571.
- Taylor DJ, Mallen C, McDougall N, et al. Effect of iron supplementation on serum ferritin levels during and after pregnancy. Br J Obstet Gynaecol. 1982;89(12):1011– 1017.


- Allen LH. Multiple micronutrients in pregnancy and lactation: an overview. Am J Clin Nutr. 2005;81(5 suppl):1206S– 1212S.
- Scholl TO. Iron status during pregnancy: setting the stage for mother and infant. Am J Clin Nutr. 2005;81(5 suppl):1218S– 1222S.
- Villar J, Rivera J. Nutritional supplementation during two consecutive pregnancies and the interim lactation period: effect on birth weight. Pediatrics. 1988;81(1):51–57.
- Jasienska G. Low birth weight of contemporary African Americans: an intergenerational effect of slavery? Am J Hum Biol. 2009;21(1):16–24.
- . Lumey LH, Stein AD. Offspring birth weights after maternal intrauterine undernutrition: a comparison within sibships. Am J Epidemiol. 1997;146(10):810–819.
- Ramakrishnan U, Martorell R, Schroeder DG, et al. Role of intergenerational effects on linear growth. J Nutr. 1999; 129(suppl):544S–549S.
- Selling KE, Carstensen J, Finnstro¨m O, et al. Intergenerational effects of preterm birth and reduced intrauterine growth: a population-based study of Swedish motheroffspring pairs. BJOG. 2006;113(4):430–440.
- Nafee TM, Farrell WE, Carroll WD, et al. Epigenetic control of fetal gene expression. BJOG. 2008;115(2):158–168.
- Waterland RA, Jirtle RL. Early nutrition, epigenetic changes at transposons and imprinted genes, and enhanced susceptibility to adult chronic diseases. Nutrition. 2004;20(1):63–68.
- Dubay L, Joyce T, Kaestner R, et al. Changes in prenatal care timing and low birth weight by race and socioeconomic status: implications for the Medicaid expansions for pregnant women. Health Serv Res. 2001;36(2):399–403.
- Fairley L, Leyland AH. Social class inequalities in perinatal outcomes: Scotland 1980–2000. J Epidemiol Community Health. 2006;60(1):31–36.
- Jansen PW, Tiemeier H, Jaddoe VW, et al. Explaining educational inequalities in preterm birth: the Generation R Study. Arch Dis Child Fetal Neonatal Ed. 2009;94(1): F28–F34.
- Kramer MS, Se´guin L, Lydon J, et al. Socio-economic disparities in pregnancy outcome: why do the poor fare so poorly? Paediatr Perinat Epidemiol. 2000;14(3):194–210.


- Morgen CS, Bjørk C, Andersen PK, et al. Socioeconomic position and the risk of preterm birth—a study within the Danish National Birth Cohort. Int J Epidemiol. 2008;37(5): 1109–1120.
- Torres-Arreola LP, Constantino-Casas P, Flores-Herna´ndez S, et al. Socioeconomic factors and low birth weight in Mexico [electronic article]. BMC Public Health. 2005;5:e20–e26.
- Finch BK. Socioeconomic gradients and low birth-weight: empirical and policy considerations. Health Serv Res. 2003; 38(6):1819–1842.
- Kamau-Mbuthia E, Elmadfa I. Diet quality of pregnant women attending an antenatal clinic in Nakuru, Kenya. Ann Nutr Metab. 2007;51(4):324–330.