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Review Article

The Association Between Maternal Nutritional Status and Intrauterine Growth Restriction: A Literature Review

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Abstract

Background: Intrauterine Growth Restriction (IUGR) is a pathological condition in which the fetus fails to achieve its genetically determined growth potential and remains a major contributor to perinatal morbidity and mortality. Maternal nutritional status is a key modifiable factor influencing placental function and fetal growth.
Aim: This study aimed to analyse the association between maternal nutritional status and the occurrence of intrauterine growth restriction.
Methods: This study employed a descriptive-analytic literature review approach. Scientific articles published within the last ten years were reviewed. Maternal nutritional indicators analysed included pre-pregnancy body mass index (BMI), mid-upper arm circumference (MUAC), gestational weight gain, haemoglobin levels, and macro- and micronutrient intake.
Results: Poor maternal nutritional status, including low BMI, MUAC <23.5 cm, inadequate gestational weight gain, anaemia, and micronutrient deficiencies, was consistently associated with an increased risk of IUGR. These conditions were linked to placental insufficiency, reduced uteroplacental perfusion, and chronic fetal hypoxia.
Conclusion: Maternal nutritional status is significantly associated with intrauterine growth restriction. Optimising maternal nutrition before and during pregnancy is essential to prevent IUGR and improve perinatal outcomes.

Keywords: *maternal nutritional status, intrauterine growth restriction, pregnancy, placental insufficiency*

INTRODUCTION

Intrauterine Growth Restriction (IUGR), also known as Fetal Growth Restriction (FGR), is a condition characterized by the inability of the fetus to achieve its genetically determined growth potential during intrauterine life. It represents one of the most significant contributors to neonatal morbidity and mortality after prematurity. remains a significant global health challenge,

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characterized by the fetus's failure to achieve its biological growth potential due to various pathological factors [1,2].

The World Health Organization (WHO) estimates that approximately 15% to 20% of all births worldwide are affected by Low Birth Weight (LBW), a condition closely linked to IUGR. In Indonesia, the prevalence of fetal growth issues remains a major public health concern. Based on national health data (Riskesdas), the incidence of LBW in Indonesia is approximately 6.2%, which is often a direct clinical manifestation of undetected or poorly managed IUGR. This condition contributes significantly to Indonesia's neonatal mortality rate and is a primary driver of the high stunting prevalence in the country, which reached 21.5% in 2023 [3,4].

The etiology of IUGR is multifactorial, involving maternal, fetal, and placental components. Among these, maternal nutritional status is recognized as the most significant modifiable risk factor. In Indonesia, a substantial number of pregnant women suffer from Chronic Energy Deficiency (CED/KEK), often indicated by a Mid-Upper Arm Circumference (MUAC/LILA) of less than 23.5 cm. This nutritional deficit, frequently exacerbated by maternal anemia and micronutrient deficiencies such as Vitamin D and iron, leads to impaired placental development and suboptimal nutrient transfer across the uteroplacental unit. When the supply of oxygen and essential nutrients is compromised, the fetus undergoes physiological adaptations that may lead to permanent structural and functional changes [5,6].

The clinical implications of IUGR are profound, spanning from the immediate neonatal period to adulthood. In the short term, infants with growth restriction are at higher risk for perinatal asphyxia, hypoglycemia, and hypothermia. Furthermore, according to the "Barker Hypothesis" or the fetal programming theory, growth-restricted fetuses are predisposed to developing non-communicable diseases later in life, including obesity, hypertension, and type 2 diabetes. Despite its severity, the early identification of IUGR through maternal nutritional assessment and antenatal monitoring remains suboptimal in many clinical settings. Therefore, this study aims to synthesize current literature to provide a comprehensive understanding of how maternal nutritional status correlates with the incidence of IUGR, particularly within the Indonesian context, to support better preventive strategies and clinical management [1,3,7].

Therefore, a comprehensive understanding of the relationship between maternal nutritional status and intrauterine growth restriction is essential to support evidence-based interventions aimed at improving maternal and fetal health outcomes [8,9].

METHODS

Study Design: This study employed a literature review using a descriptive-analytical approach. The primary objective was to collect, review, and synthesize empirical findings regarding the association between maternal nutritional indicators during pregnancy and the incidence of Intrauterine Growth Restriction (IUGR).

Data Sources and Search Strategy: A systematic search for literature was conducted across several reputable national and international electronic databases, including PubMed, ScienceDirect, Scopus, Google Scholar, and ProQuest. The search was limited to scientific articles published within the last decade (2015–2025) to ensure the inclusion of contemporary clinical data. In addition to peer-reviewed journals, official reports from the World Health Organization (WHO) and UNICEF were utilized as supplementary evidence.

The study selection process adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The selection process followed a systematic

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screening based on specific inclusion criteria, included if they were peer-reviewed articles in English or Indonesian that evaluated the direct relationship between maternal nutritional indicators such as BMI, MUAC, hemoglobin levels, and nutrient intake and fetal growth parameters. Conversely, non-human studies, editorial opinions, and articles without available full-text were excluded to preserve the analytical quality of the review. Through this systematic screening process of titles, abstracts, and full texts, a final selection of 10 articles was identified for thematic and narrative synthesis, providing a comprehensive overview of the nutritional factors influencing fetal development.

The search strategy was guided by a specific list of keywords, namely: "maternal nutritional status", "intrauterine growth restriction (IUGR)", "fetal growth restriction (FGR)", "body mass index (BMI)", "mid-upper arm circumference (MUAC/LILA)", "gestational weight gain (GWG)", "maternal anemia", and "placental insufficiency".

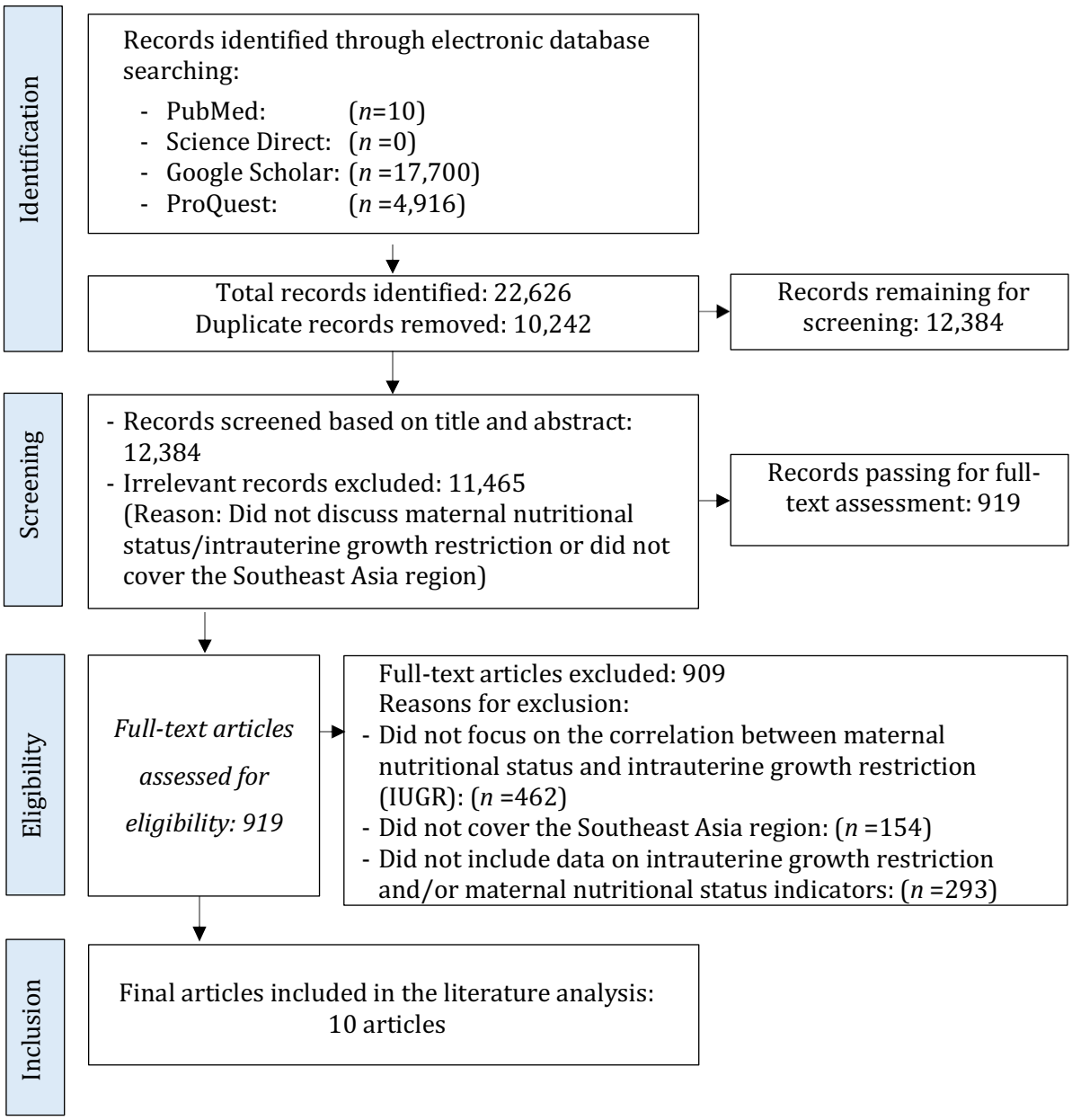

Figure 1. PRISMA flow chart of the literature search and study selection process.

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RESULTS

The literature search yielded a total of selected studies that met the predefined inclusion criteria. The included studies predominantly employed observational designs, including cross-sectional, case–control, and cohort studies, and involved pregnant women across various gestational ages. Maternal nutritional status was assessed using indicators such as pre-pregnancy body mass index (BMI), mid-upper arm circumference (MUAC), gestational weight gain, hemoglobin levels, and macro- and micronutrient intake. Fetal growth outcomes were reported as intrauterine growth restriction (IUGR) or fetal growth restriction (FGR), commonly defined as estimated fetal weight or birth weight below the 10th percentile for gestational age. The main characteristic of the included studies are summerized in Table [10,11,12].

Table 1. Characteristics of Included Studies

No	Researcher (Year)	Research Title	Research Design	Variables Studied	Main Findings
1	Rukmantara AR et al. (2023)	Correlation between Nutritional Status of Pregnant Women with Anemia and Fetal Weight Growth	Observational Analytic (Cross-sectional)	Maternal nutritional status, anemia, fetal weight	There is a significant correlation between the nutritional status of pregnant women with anemia and lower fetal weight, indicating a risk of growth restriction.
2.	Kasim E et al (2023)	Correlation between Nutritional Status and Fetal Abdominal Circumference in Pregnant Women with Anemia	Cross-sectional	Maternal nutritional status, anemia, fetal abdominal circumference	Poor maternal nutritional status is associated with smaller fetal abdominal circumference, as an indicator of restricted fetal growth.
3.	Kabahenda MK et al (2024).	Associations between maternal dietary intake and nutritional status with fetal growth at 14 to 26 weeks gestation: a cross-sectional study	Cross-sectional	Maternal dietary intake, maternal nutritional status, fetal growth	Inadequate maternal nutritional status and dietary intake are associated with restricted fetal growth at 14–26 weeks of gestation.
4.	Arnan F et al (2024).	Vitamin D and intrauterine growth restriction: a cross-sectional study	Cross-sectional	Maternal Vitamin D status, IUGR	Vitamin D deficiency in pregnant women is significantly associated with the incidence of IUGR, reflecting intrauterine growth restriction.
5.	Aquarista N et al (2023)	Correlation between Nutritional Status of Pregnant Women with Anemia and Fetal Femur Length	Cross-sectional	Maternal nutritional status, anemia, fetal femur length	Poor maternal nutritional status is associated with shorter fetal femur length, indicating growth disturbance.

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6	Durá-Travé T et al (2025).	Vitamin D and Intrauterine Growth Restriction (IUGR)	Observational Analytic	Maternal Vitamin D status, IUGR	Vitamin D deficiency during pregnancy is associated with an increased risk of IUGR due to impaired growth.
7	Nita V et al (2025)	Correlation between Maternal Nutritional Status During Pregnancy and the Incidence of LBW in Toddlers	Retrospective Cohort	Maternal nutritional status, LBW	oor maternal nutritional status during pregnancy is associated with the incidence of Low Birth Weight (LBW), which is an impact of restricted fetal growth.
8.	Ningdiah AK et al (2023).	Correlation between Nutritional Status of Pregnant Women with Anemia and Birth Weight at BPM Bidan Sri Harti	Cross-sectional	Maternal nutritional status, anemia, birth weight	Pregnant women with poor nutritional status tend to give birth to infants with low birth weight due to suboptimal fetal growth.
9.	Pane NK et al (2025).	Nutritional Status of Pregnant Women as a Predictor of Stunting Incidence in Children Aged 24-59 Months in South Padangsidimpuan District	Cohort	Maternal nutritional status, stunting	Maternal nutritional status during pregnancy affects fetal growth, which has a long-term impact on the incidence of child stunting.
10.	Agustin L et al (2025).	Influence of Pregnancy Factors on Birth Length as an Early Indicator of Stunting Risk in Kediri Regency	Cross-sectional	Maternal nutritional status, birth length	Poor maternal nutritional status is associated with shorter birth length, reflecting restricted fetal growth.

Quantitative findings demonstrated that low maternal BMI was significantly associated with IUGR, with reported p-values <0.05 in the majority of studies and adjusted odds ratios ranging approximately from 1.5 to 3.2. MUAC <23.5 cm was also consistently associated with an increased risk of IUGR, with several studies reporting statistically significant associations ($p<0.05$). Inadequate gestational weight gain was identified as a significant risk factor for IUGR, with relative risks and odds ratios indicating a higher likelihood of growth restriction among affected pregnancies [13,14].

Furthermore, maternal anemia, defined as hemoglobin levels <11 g/dL, showed a significant association with IUGR in multiple studies, with reported confidence intervals not crossing unity. Additionally, deficiencies in essential micronutrients, including iron and vitamin D, were associated with an increased prevalence of IUGR. Descriptive statistics and inferential outcomes for each nutritional indicator are summarized in the corresponding tables [8,13,15].

DISCUSSIONS

The findings of this literature review underscore the critical relationship between maternal nutritional status and the incidence of Intrauterine Growth Restriction (IUGR) or Fetal

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Growth Restriction (FGR). Maternal nutrition acts as a fundamental modifiable factor that directly influences fetal development through several physiological pathways, primarily involving placental function and nutrient transfer [9,15,16].

Maternal Nutritional Indicators and Fetal Growth

Various anthropometric indicators, such as Body Mass Index (BMI) and Mid-Upper Arm Circumference (MUAC/LILA), serve as reliable predictors for IUGR. Mothers with a MUAC below the threshold of 23.5 cm are at a higher risk of Chronic Energy Deficiency (CED/KEK). This condition is significantly associated with suboptimal placental development, characterized by reduced placental weight and size, which ultimately impairs the transfer of essential nutrients, oxygen, and hormones to the fetus. Furthermore, inadequate Gestational Weight Gain (GWG) has been shown to correlate with lower fetal growth parameters, including reduced Abdominal Circumference (AC) and Femur Length (FL) [15,17,18].

The Role of Maternal Anemia and Micronutrients

Maternal anemia, particularly iron deficiency, remains a major contributor to IUGR. Low hemoglobin levels and, more sensitively, low ferritin levels which reflect the body's iron stores are linked to increased risk of placental insufficiency. This condition reduces the blood's oxygen-carrying capacity, leading to chronic fetal hypoxia and subsequent growth restriction. Additionally, recent studies highlight the significance of Vitamin D deficiency as a potent risk factor for IUGR, as it plays a crucial role in maintaining intrauterine growth and overall fetal health [10,13,17].

Pathophysiological Mechanisms

The pathophysiology of IUGR in the context of maternal malnutrition involves a failure of the fetus to reach its genetic growth potential. When nutritional intake is insufficient, maternal physiological adaptations, such as decreased blood volume, can force the heart to work harder, leading to suboptimal uterine perfusion. This often results in asymmetric IUGR, where the fetal brain is relatively spared (brain-sparing effect) while the abdominal circumference is significantly reduced due to depleted glycogen stores in the fetal liver. Conversely, early-onset nutritional deprivation during the hyperplasia phase (first half of pregnancy) can lead to symmetric IUGR, where all fetal parameters are proportionally reduced due to a permanent decrease in total cell count [5,12,16].

The Role of Ultrasonography and Amniotic Fluid Assessment in IUGR Monitoring

Ultrasonography (USG) plays a pivotal role in the diagnosis and monitoring of Intrauterine Growth Restriction (IUGR) by providing objective evidence of impaired fetal growth and placental function in pregnancies complicated by poor maternal nutritional status. Standard biometric parameters, including biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL), are essential for identifying growth deviations below the 10th percentile, with AC being the most sensitive indicator of hepatic glycogen depletion due to chronic nutrient deprivation. Maternal malnutrition and chronic energy deficiency frequently lead to placental insufficiency, manifesting as asymmetric IUGR with a "brain-sparing effect" or symmetric IUGR depending on the timing of deprivation. Furthermore, the assessment of amniotic fluid volume through the Amniotic Fluid Index (AFI) or Single Deepest Pocket (SDP) is a critical component of fetal surveillance, as oligohydramnios—resulting from reduced fetal renal perfusion and chronic hypoxia—is consistently associated with adverse perinatal outcomes. In

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the Indonesian context, where maternal anemia and low mid-upper arm circumference (MUAC) remain prevalent, the integration of serial ultrasound evaluations and maternal nutritional assessments offers a cost-effective strategy for early risk stratification and the optimization of clinical management to improve fetal growth [19,20,21,22].

Clinical and Long-term Implications

The impact of maternal nutrition extends beyond birth. Based on the Early Life Theory, the first 1,000 days of life are critical. Infants born with Low Birth Weight (LBW) due to IUGR are at a 6 to 10 times higher risk of neonatal mortality compared to normal-growth fetuses. Long-term consequences include an increased risk of stunting, cognitive impairments, and chronic metabolic diseases in adulthood. Therefore, early detection through antenatal monitoring (using gravidograms and ultrasound/USG) and nutritional interventions are paramount in improving perinatal outcomes [23,24,25].

The findings of this review support the developmental origins of health and disease (DOHaD) hypothesis, which states that adverse intrauterine environments, including poor maternal nutrition, can alter fetal programming and increase the risk of metabolic and cardiovascular diseases later in life. However, heterogeneity in study design, nutritional assessment tools, and definitions of IUGR among the included studies should be considered when interpreting these results [6].

Overall, this literature review emphasizes the importance of optimizing maternal nutritional status before and during pregnancy as a key preventive strategy for intrauterine growth restriction. Strengthening maternal nutrition interventions and antenatal nutritional monitoring may contribute to improved fetal growth and better perinatal outcomes [6,17].

CONCLUSIONS

This literature review concludes that maternal nutritional status is significantly associated with the occurrence of intrauterine growth restriction (IUGR). Poor maternal nutritional indicators, including low pre-pregnancy body mass index, reduced mid-upper arm circumference, inadequate gestational weight gain, and maternal anemia, are consistently linked to an increased risk of impaired fetal growth. In addition, deficiencies in essential micronutrients, particularly iron and vitamin D, contribute to placental dysfunction and suboptimal fetal development. These findings highlight the critical role of adequate maternal nutrition in supporting placental function and ensuring optimal fetal growth. Therefore, improving maternal nutritional status before and during pregnancy should be prioritized as a key strategy to prevent intrauterine growth restriction and enhance perinatal outcomes.

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Ethical Clearance

This study is a literature review based exclusively on previously published research. No human participants or animals were involved, and no primary or secondary data were collected. Therefore, ethical approval was not required.

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Declaration of Conflicting Interest

The author (s) declared no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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