International Journal of Scientific Advances
ISSN: 2708-7972
Volume: 7 | Issue: 4 | Jul – Aug 2026 Available Online: www.ijscia.com
DOI: 10.51542/ijscia.v7i4.5

Relationship Between Maternal Nutritional Status and Low Birth Weight at Airlangga University General Hospital: A Case Control Study

Erinda Fairuz Ramadhani[1], Widati Fatmaningrum[2*], Budi Prasetyo[3], Mahendra Tri Arif Sampurna[4]

[1]Medical Program, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

[2]Department of Public Health Sciences-Preventive Medicine, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

[3]Departement of Obstetrics and Gynecology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

[4]Department of Pediatrics, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

E-mail: erinda.fairuz.ramadhani-2023@fk.unair.ac.id; widati-f@fk.unair.ac.id; budi-p@fk.unair.ac.id

*Corresponding author details: Widati Fatmaningrum; widati-f@fk.unair.ac.id

ABSTRACT

Introduction: Low birth weight (LBW) is a vital benchmark in neonatal health assessment, given its direct link to elevated newborn illness and death rates. The energy and food reserves needed to sustain metabolic adaptation, placental expansion, and early fetal development may be shown by a mother's pre-pregnancy body mass index (BMI), which is an indicator of her nutritional state before pregnancy. The link between BMI before pregnancy and LBW, however, is still poorly understood. ***Objective:*** To analyze the relationship between pre-pregnancy BMI and the incidence of LBW at Airlangga University General Hospital in 2025. ***Methods:*** This retrospective case–control design examined 60 participants (comprising 30 LBW subjects and 30 normal-weight controls) recruited via consecutive sampling. Information was extracted from patient medical charts. Statistical assessments utilized Chi-square with odds ratio (OR), independent t-test, multivariate logistic regression, Kruskal–Wallis test, and post hoc Mann–Whitney with Bonferroni correction. ***Results:*** A highly meaningful correlation emerged between maternal pre-pregnancy BMI and LBW ($p<0.001$). Underweight mothers faced a 16.789 times greater probability of delivering LBW infants than non-underweight counterparts. Average BMI values varied substantially between the case and control cohorts ($p<0.001$). Multivariate modeling confirmed pre-pregnancy BMI as the primary determinant tied to LBW (OR=12.176; $p=0.026$). Furthermore, birth weight distribution differed significantly across maternal BMI strata ($p<0.001$), particularly between underweight vs. overweight/obese cohorts and normal vs. obese cohorts. Conversely, no statistically significant variations were found within the underweight cohort itself.

Keywords: pre-pregnancy BMI; underweight; low birth weight; maternal nutrition status.

INTRODUCTION

On a global scale, Low birth weight (LBW) continues to pose a critical public health challenge, directly driving up rates of newborn complications and fatalities. As specified by the World Health Organization (WHO) guidelines, this clinical condition involves an infant weighing under 2500 grams at delivery. Around 15% to 20% of all infants worldwide are affected by this condition, which translates into a global annual burden exceeding 20 million births [1]. In Indonesia, the prevalence of LBW has shown an increasing trend, rising from 2.5% in 2022 to 3.9% in 2023. A similar increase has been observed in Surabaya, where the prevalence rise from 1.73% to 3.4% during the same period [2]. LBW significantly contributes to neonatal mortality, with approximately 6.1% of neonatal deaths in Indonesia [3].

Neonatal birth weight is fundamentally shaped by the mother's nutritional condition. Metrics including pre-pregnancy body mass index (BMI) and gestational weight gain serve as mirrors of maternal dietary adequacy, directly shaping intrauterine growth.

Being underweight or experiencing insufficient weight advancement throughout gestation can disrupt placental maturation and diminish the transport of vital nutrients to the fetus, thereby elevating LBW probabilities [4]. Underweight status in pregnant women is one of the major nutritional concerns. Data from Indonesia indicate that about 7.5% of the female population suffers from being underweight, and a substantial 10.2% of expectant mothers exhibit a deficit in nutritional status at the onset of pregnancy [5][6]. Furthermore, insufficient gestational weight gain significantly elevates LBW risks, especially in women entering pregnancy underweight [7].

METHODS

This analytic observational study utilized a case-control design at Airlangga University General Hospital, leveraging secondary data extracted retrospectively from medical records. The population consisted of all live-born infants delivered at Airlangga University General Hospital in 2025.

The study sample comprised 60 samples (30 low birth weight and 30 normal weight controls) selected consecutively at Airlangga University General Hospital based on a maternal age criterion of 20–35 years. Exclusion criteria included infants with congenital abnormalities, prematurity, multiple births, and mothers with chronic diseases or pregnancy complications that could affect fetal growth.

Researchers analyzed data utilizing univariate, bivariate, and multivariate techniques. The correlation involving maternal pre-pregnancy BMI and LBW was evaluated using Chi-square testing, followed by calculating the odds ratio (OR). An independent t-test measured how gestational weight gain relates to LBW measured as continuous data. To examine newborn birth weight variations across maternal nutritional status categories and inside the underweight subgroup, the Kruskal–Wallis test was implemented. Additionally, specific cohort variations were uncovered through post hoc evaluation. Independent risk factors driving low birth weight occurrences were identified via multivariate logistic regression analysis. The level of statistical significance was defined as $p<0.05$.

RESULT

TABLE 1: Maternal Characteristics.

Variable	Category	Case (n=30) n (%) / Mean ± SD	Control (n=30) n (%) / Mean ± SD
Age (years)	Mean ± SD	27.96 ± 4.42	29.1 ± 4.42
	Median	29.00	29.00
	Mode	29	29
	Min-Max	20-35	20-35
Parity	Primipara	19 (63.3%)	10 (33.3%)
	Multipara	11 (36.7%)	20 (66.7%)
Pregnancy Interval (years)	Median	4.75	4
	Mode	2	5
	Min-Max	2-12	2-9
Maternal Height (cm)	Mean ± SD	153.20 ± 5.28	154.23 ± 5.92
	Median	153	155
	Mode	153	154
	Min-Max	144-160	140-164

TABLE 2: Neonatal Anthropometric and Delivery Profiles.

Variable	Category	Case (n=30) n (%) / Mean ± SD	Control (n=30) n (%) / Mean ± SD
Sex	Female	20 (66.7%)	13 (43.3%)
	Male	10 (33.3%)	17 (56.7%)
Mode of delivery	Vaginal	20 (66.7%)	15 (50%)
	Cesarean section	10 (33.3%)	15 (50%)
Birth length (cm)	Median	47	50
	Mode	47	49
	Min-Max	42-49	47.5-52
Head circumference (cm)	Median	31	34
	Mode	30	34
	Min-Max	29-33	30.5-35.5

TABLE 3: Bivariate Analysis of Maternal Nutritional Status and LBW.

Variable	Category	Cases (LBW) n (%)	Controls (Non-LBW) n (%)	p-value	OR	95% CI
Pre-pregnancy BMI	Underweight	11 (36.7%)	1 (3.3%)	0.001	16.789	2,001 – 140,898
	Not underweight	19 (63.3%)	29 (96.7%)			
Gestational Weight Gain	Below recommendation	20 (66.7%)	9 (30%)	0.006	4.66	1.571 – 13.86
	Not below recommendation	10 (33.3%)	21 (70%)			

TABLE 4: Multivariate Logistic Regression of LBW Predictors.

	p-value	Adjusted OR (AOR)	95% CI
Pre-pregnancy BMI (underweight)	0.026	12.176	1.353 – 109.567
Gestational weight gain (below recommendation)	0.051	3.221	0.994 – 10.444
Maternal Height	0.398	0.954	0.857 – 1.063

TABLE 5: Birth Weight Distribution Across Pre-pregnancy BMI Categories (Kruskal-Wallis Test).

Pre-pregnancy BMI Category	n	Median (Min-Max) (grams)	p-value
Underweight	12	2307 (1830 – 3180)	<0.001
Normal	17	2430 (1870 – 3278)	
Overweight	20	3129 (2130 – 3700)	
Obesitas	11	3190 (2845 – 3796)	

TABLE 6: Pairwise Comparisons of Birth Weight Between Pre-pregnancy BMI Categories (Mann-Whitney Test with Bonferroni Correction).

	p-value	Interpretation
Underweight vs Normal	0.092	Not significant
Underweight vs Overweight	<0.001	Significant
Underweight vs Obesities	<0.001	Significant
Normal vs Overweight	0.002	Not significant
Normal vs Obesities	<0.001	Significant
Overweight vs Obesities	0.248	Not significant

DISCUSSION

Maternal Characteristics

According to Table 1, mothers in the case group tended to be younger than those in the control group, with a mean age of 27.96 ± 4.42 years compared to 29.10 ± 4.42 years. However, because all participants shared an ideal childbearing age, maternal age showed no strong link to LBW. This aligns with prior research indicating that narrow age ranges do not substantially affect infant birth weight [8]. Primiparity was more common among cases (63.3%) than controls (33.3%), whereas multiparity predominated in the control group. This may be related to limited maternal experience, inadequate knowledge of pregnancy care, and ongoing physiological adaptation during the first pregnancy [9]. However, previous studies have reported inconsistent findings regarding the association between parity and LBW [10]. Birth interval showed that mothers in the case group had a slightly longer median pregnancy interval (4.75 years compared to 4 years) and a lower mean maternal height (153.20 ± 5.28 cm compared to 154.23 ± 5.92 cm) than those in the control group. Short or suboptimal maternal stature is often associated with chronic malnutrition, which may influence maternal physiological conditions during pregnancy and subsequently affect fetal growth [11].

Infant Characteristics

The case group exhibited a higher frequency of female infants than the control cohort. This outcome likely reflects divergent fetal development pathways between sexes, as male and female fetuses possess discrete biological characteristics in utero. However, sex is not considered a direct determinant of impaired fetal growth and may instead reflect the characteristics of the study population [12]. With respect to delivery approaches, vaginal extraction was prevalent in the case cohort, whereas controls displayed a balanced split between vaginal and cesarean sections. This outcome implies that childbirth methods were not significantly disparate across both groups. Previous studies have reported that cesarean section is primarily performed based on maternal and fetal indications rather than birth weight alone [13].

The case group also had a shorter median birth length than the control group, indicating suboptimal linear fetal growth during pregnancy. Because this study exclusively included term infants, diminished birth length likely stems from intrauterine growth restriction (IUGR) or small-for-gestational-age (SGA) rather than preterm birth [14]. Additionally, cases exhibited a smaller median head circumference than controls, which may indicate constrained fetal growth, particularly in IUGR or SGA infants, though long-term neurodevelopment is also driven by postnatal nutrition and environment [15].

Maternal Nutritional Status and Low Birth Weight

This study confirms that maternal nutritional status strongly influences LBW. Mothers with an underweight pre-pregnancy BMI faced a substantially higher risk of delivering LBW infants (OR = 16.789), highlighting preconception nutrition as a key driver of fetal growth. These results align with previous literature demonstrating that women with a pre-pregnancy BMI below 18.5 kg/m^2 experience greater LBW incidence than those with normal weight [16].

Pre-pregnancy BMI reflects maternal energy and nutrient reserves required to support metabolic adaptation, placental development, and fetal growth throughout pregnancy. Mothers with underweight BMI generally have limited macronutrient and micronutrient stores, increasing the risk of inadequate placental vascularization and reduced uteroplacental blood flow. As a result, restricted fetal nutrient and oxygen supply impairs development, triggering intrauterine growth restriction (IUGR) and subsequent LBW [17]. Furthermore, inadequate maternal nutritional status before pregnancy has been associated with suboptimal placental function, limiting fetal growth even in term pregnancies [18]. Although the odds ratio observed in this study was higher than that reported in several previous studies, differences in study design, population characteristics, and confounding factors may explain this variation, while the direction of the association remains consistent [16].

Beyond pre-pregnancy BMI, sub-optimal GWG significantly correlates with LBW. Mothers with inadequate weight accumulation faced a 4.66-fold higher risk of delivering LBW infants than those meeting recommendations. This suggests that deficient gestational weight gain reflects poor maternal energy and nutrient consumption, ultimately restricting fetal development [19].

The Institute of Medicine (IOM) recommends adjusting GWG based on pre-pregnancy BMI, as underweight women require more weight accumulation for optimal fetal development than overweight or obese mothers. Earlier research confirms that deficient GWG correlates with higher risks of LBW, preterm birth, and restricted fetal growth, especially in women with poor preconception nutritional status [20].

Birth Weight Differences Across Pre-pregnancy BMI Categories

The Kruskal–Wallis assessment revealed a notable variance in newborn weight across pre-pregnancy BMI classifications ($p<0.001$). Infant birth weight exhibited an upward trajectory alongside rising maternal BMI, reinforcing that maternal nutritional adequacy prior to conception heavily dictates intrauterine development. Post hoc comparisons specified distinct variations between the underweight and overweight cohorts, underweight and obese clusters, alongside normal and obese subjects. This direct correlation involving pre-pregnancy BMI and birth weight remains biologically logical, as maternal nutritional capacity regulates the influx of glucose, amino acids, and lipids are essential for fetal growth. Women with overweight or obesity generally have greater nutrient availability and increased placental nutrient transfer, promoting fetal tissue growth and resulting in higher birth weight [23]. In contrast, underweight mothers have limited energy reserves, which may restrict placental nutrient transfer and increase the risk of impaired fetal growth and low birth weight [24].

Subgroup analysis among underweight mothers showed no significant difference in birth weight according to the severity of underweight ($p = 0.492$). This finding suggests that once maternal nutritional status falls below the normal range, the overall deficiency in maternal energy and nutrient reserves may already be sufficient to limit fetal growth, regardless of the degree of underweight [25]. However, this result differs from previous studies that showed a progressive increase in the risk of low birth weight with greater severity of pre-pregnancy underweight [26].

CONCLUSIONS

Maternal nutritional status before pregnancy plays an important role in determining birth weight outcomes. Underweight mothers have a significantly higher risk of delivering low birth weight infants compared to those with normal or higher nutritional status. In addition, inadequate gestational weight gain is also associated with an increased risk of low birth weight.

Pre-pregnancy body mass index operated as the primary predictor governing the prevalence of low birth weight. Variations in newborn weight were evident across maternal nutritional classifications, where elevated BMI aligned with higher birth weight outcomes. Nonetheless, no meaningful disparities were detected within the underweight cohort regarding severity levels. These outcomes underscore the necessity of optimizing maternal nutritional health prior to and throughout gestation to reduce low birth weight occurrences.

ACKNOWLEDGMENT

The authors would like to express their sincere appreciation to Airlangga University Hospital for granting permission and access to the data utilized in this study. The authors also extend their gratitude to the healthcare personnel who contributed to the data collection process and supported the implementation of this research.

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