Maternal Factors and Their Relationship with Low Birth Weight: Evidence from a Case-Control Study

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Abstract

Background: Low birth weight (LBW) remains a major public health concern due to its association with neonatal morbidity and mortality. Maternal factors during pregnancy may influence birth weight outcomes. This study aimed to examine the relationship between maternal factors and low birth weight using a case-control design.

Methods: A case-control study was conducted involving 55 mother–infant pairs, consisting of 27 LBW cases and 28 normal birth weight controls. Maternal characteristics, including age, education, employment status, gestational age, pre-pregnancy weight, post-pregnancy weight, hemoglobin levels before and after pregnancy, and infant sex, were collected. The ponderal index was also assessed. Categorical variables were analyzed using appropriate comparative tests, and continuous variables were compared using mean differences. A p-value <0.05 was considered statistically significant.

Results: Most mothers were aged 20–35 years (80.0%) and unemployed (76.4%). Nearly half had completed senior high school (49.1%). There were no significant associations between infant sex, maternal age, education, employment status, gestational age, pre-pregnancy weight, post-pregnancy weight, hemoglobin levels before pregnancy, or hemoglobin levels after pregnancy and birth weight outcome (p>0.05). However, the mean ponderal index was significantly lower in the LBW group compared to the normal birth weight group (2.47±0.36 vs. 2.84±0.24; p<0.001).

Conclusion: Among the maternal factors examined, only the ponderal index showed a significant association with low birth weight. These findings suggest that neonatal body proportionality may be an important indicator related to birth weight outcomes.

Keywords: Low birth weight, Maternal factors, Risk factors, Ponderal index

Introduction

Low birth weight (LBW), defined as a birth weight of less than 2,500 grams, remains a major public health problem worldwide.[1] Infants born with LBW are at higher risk of neonatal morbidity, impaired growth and development, and increased mortality during infancy. In addition, LBW has been associated with long-term consequences, including stunting, cognitive impairment, and a higher risk of chronic diseases in adulthood. Therefore, identifying modifiable risk factors for LBW is essential to improve maternal and child health outcomes.[1,2]

Maternal factors play a crucial role in determining fetal growth and birth weight. Several studies have reported that maternal age, educational level, employment status, nutritional status, gestational age, and hemoglobin levels during pregnancy are associated with birth weight outcomes. Inadequate maternal nutrition before and during pregnancy may impair fetal growth, while maternal anemia has been linked to intrauterine growth restriction and preterm birth.[3,4] Maternal socioeconomic factors, such as education and employment, may also influence access to health services, dietary quality, and antenatal care utilization. However, findings across

studies have been inconsistent, suggesting that the contribution of each factor may vary according to population characteristics and local contexts.[5,6]

The ponderal index, which reflects neonatal body proportionality, has also been used to assess fetal growth and nutritional status at birth. A lower ponderal index may indicate disproportionate growth restriction and has been associated with adverse neonatal outcomes.[7,8] Although several maternal determinants of LBW have been widely investigated, limited evidence is available regarding the combined role of maternal characteristics and neonatal proportionality in rural or semi-urban districts in Indonesia.[9,10]

Kabupaten Solok, located in West Sumatra Province, represents an area with diverse geographical and socioeconomic characteristics. Access to maternal health services, nutritional patterns, and educational attainment may differ from urban settings, potentially influencing pregnancy outcomes. Local data on the determinants of LBW in Solok Regency remain limited, making it important to conduct context-specific research to support evidence-based interventions.[11,12]

Therefore, this study aimed to analyze the relationship between maternal factors and low birth weight using a case-control design in Solok Regency. The findings of this study are expected to contribute to a better understanding of maternal and neonatal determinants of LBW and to provide evidence for strengthening maternal and child health programs at the district level.

Methods

Study Design and Research Sample

This study used an analytic observational design with a case-control approach. The research was conducted in Solok Regency, West Sumatra, Indonesia. The study population consisted of mothers who delivered at selected health facilities in Solok Regency during the study period.
Cases were defined as mothers who delivered infants with low birth weight (LBW), defined as birth weight <2,500 grams. Controls were mothers who delivered infants with normal birth weight (≥2,500 grams). A total of 55 mother–infant pairs were included, comprising 27 cases and 28 controls. Subjects were selected using a consecutive sampling technique based on eligibility criteria. Mothers with incomplete medical records or multiple pregnancies were excluded from the study.

Variables and Operational Definition

The dependent variable was birth weight outcome, categorized as low birth weight (<2,500 g) and normal birth weight (≥2,500 g). Independent variables included maternal and neonatal factors. Maternal age was categorized into <20 years, 20–35 years, and >36 years.[8,9] Maternal education was classified as elementary school, junior high school, senior high school, and higher education. Maternal employment status was categorized as employed or unemployed. Gestational age was measured in completed weeks at delivery. Pre-pregnancy weight and post-pregnancy weight were measured in kilograms (kg).[10,11] Hemoglobin (Hb) levels before and after pregnancy were measured in grams per deciliter (g/dL). The ponderal index was calculated using the formula: birth weight (grams) divided by birth length (cm³) × 100, and was expressed as a continuous variable.[2,12]

Data Collection Technique

Data were collected from maternal and neonatal medical records available at health facilities in Solok. Regency Information on maternal characteristics, pregnancy history, hemoglobin levels, and birth outcomes was extracted using a structured data collection form. Data completeness and accuracy were checked prior to analysis.

Ethical Consideration

This study was approved by the Research Ethics Committee of Dr. M. Djamil General Hospital, Padang Municipality, Indonesia (No. DP.04.03/D.XVI.XI/601/2025).

Data Analysis

Data were analyzed using statistical software. Descriptive analysis was performed to summarize the characteristics of the subjects. Categorical variables were presented as frequencies and percentages, while continuous variables were presented as means and standard deviations. Bivariate analysis was conducted to examine the association between maternal factors and birth weight outcomes. A p-value of less than 0.05 was considered statistically significant.

Results

The characteristics of the subjects are presented in Table 1.

Table 1. Characteristics of the subjects

Variable	Value
Infant sex, f(%)	
Male	23 (41.8)
Female	32 (58.2)
Maternal age, f(%)	
<20 years	1 (1.8)
20-35 years	44 (80.0)
>36 years	10 (18.2)
Maternal education, f(%)	
Elementary school	2 (3.6)
Junior high school	15 (27.3)
Senior high school	27 (49.1)
Higher education	11 (20.0)
Maternal employment status, f(%)	
Unemployed	42 (76.4)
Employed	13 (23.6)
Gestational age (years), mean±SD	38.25±1.21
Pre-pregnancy weight (Kg), mean±SD	72.67±6.29
Post-pregnancy weight (Kg), mean±SD	82.89±8.11
Hemoglobin level before pregnancy (gr/dL), mean±SD	8.33±0.81
Hemoglobin level after pregnancy (gr/dL), mean±SD	8.79±0.88
Ponderal index, mean±SD	2.66±0.35

Table 1 showed less than half of the infants were male (41.8%), while 58.2% were female. Most mothers were aged 20–35 years (80.0%), followed by >36 years (18.2%), and <20 years (1.8%). Nearly half of the mothers had completed senior high school (49.1%), while 27.3% had completed junior high school, 20.0% had completed higher education, and 3.6% had completed elementary school. The majority of mothers were unemployed (76.4%), while 23.6% were employed. The mean gestational age was 38.25 ± 1.21 years. The mean maternal weight before pregnancy was 72.67 ± 6.29 kg, and after pregnancy was 82.89 ± 8.11 kg. The mean hemoglobin (Hb) level before pregnancy was 8.33 ± 0.81 g/dL, and after pregnancy was 8.79 ± 0.88 g/dL. The mean ponderal index was 2.66 ± 0.35. Maternal factors and birth weight outcomes are presented in Table 2.

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Table 2. Maternal factors and birth weight outcomes

Variable	Low birth weight (n=27)	Normal (n=28)	P-value
Infant sex, f(%)			
Male	11 (47.8)	12 (52.2)	

Female	16 (50.0)	16 (50.0)	
Maternal age, f(%)			0.501
<20 years	1 (100.0)	0	
20-35 years	22 (50.0)	22 (50.0)	
>36 years	4 (40.0)	6 (60.0)	
Maternal education, f(%)			0.438
Elementary school	2 (100.0)	0	
Junior high school	6 (40.0)	9 (60.0)	
Senior high school	13 (48.1)	14 (51.9)	
Higher education	6 (54.5)	5 (45.5)	
Maternal employment status, f(%)			0.576
Unemployed	22 (52.4)	20 (47.6)	
Employed	5 (38.5)	8 (61.5)	
Gestational age (years), mean±SD	38.19±1.15	38.32±1.28	0.679
Pre-pregnancy weight (Kg), mean±SD	71.52±6.00	73.79±6.48	0.184
Post-pregnancy weight (Kg), mean±SD	81.19±7.09	84.54±8.78	0.126
Hemoglobin level before pregnancy (gr/dL), mean±SD	8.33±0.78	8.34±0.85	0.989
Hemoglobin level after pregnancy (gr/dL), mean±SD	8.81±0.88	8.78±0.89	0.893
Ponderal index, mean±SD	2.47±0.36	2.84±0.24	<0.001*

*P<0.05 considered statistically significant

Table 2 showed there was no significant association between infant sex (p = 1.000), maternal age (p = 0.501), maternal education (p = 0.438), maternal employment status (p = 0.576), gestational age (p = 0.679), maternal weight before pregnancy (p = 0.184), maternal weight after pregnancy (p = 0.126), hemoglobin level before pregnancy (p = 0.989), or hemoglobin level after pregnancy (p = 0.893) and birth weight outcome (p > 0.05). However, there was a significant association between the ponderal index and birth weight outcome (p < 0.001).

Discussion

This study examined the relationship between maternal factors and low birth weight (LBW) in Solok Regency using a case-control design. The findings showed that most maternal characteristics, including maternal age, education, employment status, gestational age, pre-pregnancy weight, post-pregnancy weight, and hemoglobin levels before and after pregnancy, were not significantly associated with birth weight outcomes. However, the ponderal index was significantly associated with LBW.

The absence of a significant association between maternal age and LBW in this study may be explained by the fact that the majority of mothers were within the optimal reproductive age range of 20–35 years. This age group is generally considered biologically favorable for pregnancy outcomes, which may have reduced the variability needed to detect a significant relationship.[12,13] Similarly, maternal education and employment status were not significantly associated with LBW. Although socioeconomic factors are often linked to pregnancy outcomes, their effect may have been mediated by access to antenatal care services that were relatively uniform across the study setting.[13,14]

Gestational age did not show a significant association with birth weight outcome, likely because most pregnancies were carried to term, as indicated by the mean gestational age of approximately 38 weeks in both groups. In addition, maternal weight before and after pregnancy did not differ significantly between LBW and

normal birth weight groups.[15,16] This finding suggests that overall maternal body weight alone may not adequately reflect nutritional status or placental function, which are more directly related to fetal growth. Hemoglobin levels before and after pregnancy were also not significantly associated with LBW.[13,14] Although maternal anemia has been reported as a risk factor for intrauterine growth restriction, the relatively similar mean hemoglobin levels in both groups may have limited the ability to detect a meaningful difference.[13,16]

In contrast, the ponderal index showed a significant association with birth weight outcome. Infants in the LBW group had a significantly lower mean ponderal index compared to those with normal birth weight. The ponderal index reflects neonatal body proportionality and may indicate intrauterine growth restriction.[17-19] A lower value suggests disproportionate growth, which may result from chronic nutritional or placental insufficiency during pregnancy.[18-20]

These findings highlight the importance of assessing neonatal body proportionality in addition to maternal characteristics when evaluating birth outcomes. Further studies with larger sample sizes and additional variables are recommended to better understand the determinants of LBW in Solok Regency and similar settings.

This study had several strengths. The use of medical record data minimized recall bias and ensured objective measurement of clinical variables, such as birth weight and hemoglobin levels. In addition, the study provided local evidence from Solok Regency, generating context-specific findings that may support district-level maternal and child health programs and inform targeted interventions.

However, several limitations should be acknowledged. The relatively small sample size may have limited the statistical power to detect significant associations for certain variables. The reliance on secondary data from medical records may also have introduced the risk of incomplete or inaccurate documentation. Furthermore, important potential confounding factors such as maternal nutritional intake, frequency of antenatal care visits, smoking exposure, and pregnancy-related complications were not included in the analysis. Therefore, the findings should be interpreted with caution, and future studies with larger sample sizes and more comprehensive variables are recommended to provide a more robust understanding of the determinants of low birth weight.

Conclusions

This case-control study conducted in Solok Regency found that most maternal characteristics, including maternal age, education level, employment status, gestational age, pre-pregnancy weight, post-pregnancy weight, and hemoglobin levels before and after pregnancy, were not significantly associated with low birth weight. Among the variables examined, only the ponderal index showed a significant association, with lower values observed in the low birth weight group. These findings indicate that neonatal body proportionality may be an important indicator related to birth weight outcomes in this population. Further studies with larger sample sizes and more comprehensive maternal and clinical variables are needed to better understand the determinants of low birth weight and to support targeted maternal and child health interventions at the district level.

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Declaration concerning generative AI and AI-augmented technologies in the compositional process

In the course of preparing this paper, the authors utilized ChatGPT to enhance readability and linguistic quality. Subsequent to utilizing this tool/service, the writers assessed and amended the information as necessary and assume complete accountability for the publication's content.

Declarations of competing interest

No potential competing interest was reported by the authors.

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