



Deconstructing Low Birth Weight Determinants In Largest Moslem Country

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Received: May 20, 2026; Accepted: June 27, 2026

Abstract

Background: Low Birth Weight (LBW), defined as infants weighing <2,500 grams, is a major indicator of maternal and infant health. Globally, LBW prevalence remains high at 14.7% (~19.8 million births in 2020) with a slow annual decline of 0.3%. In Indonesia, LBW accounts for 39.2% of neonatal deaths, with a prevalence of 6.1% (IHS 2023), still above the RPJMN 2020–2024 target of 4%. **Objective:** To identify determinants of LBW in Indonesia using the 2023 Indonesia Health Survey (IHS) data. **Method:** A cross-sectional study using secondary IHS 2023 data was conducted. The dependent variable was LBW, while independent variables followed the WHO (2004) framework: infant factors (sex, prematurity, multiple birth), maternal factors (age, education, occupation, smoking, ANC visits, anemia, hypertension, height), and environmental factors (residence type, socioeconomic status). Analyses included descriptive statistics, chi-square, and binary logistic regression. **Results:** Significant determinants of LBW included maternal age at delivery (AOR=1.262; $p=0.009$), maternal height (AOR=1.661; $p=0.000$), hypertension status (AOR=2.503; $p=0.000$), preterm birth (AOR=7.822; $p=0.000$), infant sex (AOR=1.376; $p=0.000$), and birth type (AOR=14.805; $p=0.000$). Birth type was identified as the strongest predictor of LBW among all determinants. **Conclusion:** LBW in Indonesia is multifactorial. Preventive strategies should emphasize adolescent nutrition, quality antenatal care, and monitoring of high-risk pregnancies.

Keywords: LBW, IHS, Multifactor, Nutrition, Determinants

DOI: <https://doi.org/10.15408/jrph.v8i1.51424>

Introduction

Low Birth Weight (LBW), which refers to babies weighing less than 2,500 grams regardless of gestational age, is a key indicator in assessing the health of mothers and infants (5); (34). This condition reflects issues related to nutrition, chronic diseases, and inadequate quality of antenatal care (34). The WHO estimates that approximately 60 - 80% of neonatal deaths are attributable to LBW. Infants with LBW are also at risk of experiencing stunting, cognitive developmental delays, and degenerative diseases in adulthood (32); (35).

Globally, the prevalence of low birth weight remains high. Approximately 14.7% of infants, or 19.8 million births in 2020, were recorded as having low birth weight (32), consistent with WHO's estimate of 15%. Unfortunately, the trend of improvement is very slow, at just 0.3% per year between 2012 and 2020, which is far from the annual reduction target of 1.96% needed to achieve the WHA 2025 target of 30% (31).

In Indonesia, Low Birth Weight (LBW) is also a leading cause of neonatal mortality. LBW contributed to 39.2% of total infant deaths in 2023 (16); (19). The trend of LBW prevalence in Indonesia has shown variation since the 1991 Indonesia Demographic and Health Survey (IDHS)

(7.2%) to the 2023 Indonesia Health Survey (IHS), which recorded a figure of 6.1% (3); (4); (5); (18). Although there has been a decrease, this figure has not yet reached the target set by the National Mid-Term Development Plan (RPJMN) 2020 - 2024 of 4%.

Hospital-based evidence also demonstrates the continued burden of LBW, particularly among high-risk populations managed in referral facilities. A recent multicenter study involving 12 hospitals across Indonesia reported that LBW infants remain a vulnerable group with substantially higher risks of neonatal morbidity and mortality, highlighting the need for intensive neonatal care and improved clinical management (8). These findings indicate that LBW is a multifactorial condition influenced by infant-related factors, including prematurity and sex; maternal factors, such as maternal age, nutritional status, antenatal care utilization, smoking exposure, anemia, and hypertension; as well as environmental factors, including socioeconomic status and place of residence. Therefore, comprehensive analysis using nationally representative data is required to identify the major determinants of LBW in Indonesia.

From a religious perspective, particularly within Islamic values, maternal and child health is closely related to the responsibility of preserving life (*hifzh al-nafs*) and offspring (*hifzh al-nasl*). Pregnancy is considered a valuable phase that requires proper care, including adequate nutrition, prevention of health risks, and utilization of maternal health services as a form of responsibility and effort to protect the well-being of future generations. These values may influence health-seeking behaviors, decision-making related to pregnancy planning, and adherence to antenatal care, which are important components in preventing LBW.

Previous studies have utilized secondary national survey data to identify determinants of LBW in Indonesia. For instance, studies using the 2017 Indonesian Demographic and Health Survey (IDHS) and the 2018 Basic Health Research (Riskesdas) have examined the roles of antenatal care, maternal characteristics, and socioeconomic factors in LBW occurrence. However, these studies were limited by the scope of variables analyzed and did not comprehensively integrate maternal, infant, and pregnancy-related factors. A recent study using the 2023 Indonesian Health Survey (IHS) investigated lifestyle-related factors associated with LBW. However, clinical and biological determinants, including maternal height, hypertension, preterm birth, infant sex, and multiple birth, were not comprehensively evaluated. Therefore, this study provides additional evidence by analyzing multiple domains of LBW determinants using nationally representative IHS 2023 data.

Methods

Descriptive analysis was conducted to summarize the distribution of all study variables, while multivariate analysis using binary logistic regression was performed to identify determinants associated with LBW. The analysis applied a hierarchical modeling approach based on variable grouping. All data processing procedures were conducted using statistical software. This study used secondary data from the 2023 Indonesian Health Survey (IHS), obtained through an approved data access mechanism from the Ministry of Health of the Republic of Indonesia. The use of the dataset was authorized under the Data Confidentiality Agreement (Document Number: FRM/SMKI-PUSDATIN/70).

The dependent variable was low birth weight (LBW), defined as birth weight less than 2,500 grams regardless of gestational age (34). The independent variables were grouped based on WHO's conceptual framework for LBW determinants, including:

1. Infant-related factors: sex of the baby, premature birth, and multiple birth status.
2. Maternal-related factors: maternal age at delivery, education level, employment status, smoking status, number of antenatal care (ANC) visits, anemia status, hypertension status, and maternal height.

3. Environmental factors: residence type (urban/rural) and socioeconomic status.

Descriptive analysis was performed to describe the distribution of all study variables. Bivariate analysis using the chi-square test was conducted to assess the association between independent variables and low birth weight (LBW). Variables with a p-value < 0.25 in the bivariate analysis were included in the multivariate analysis using binary logistic regression to identify significant determinants of LBW. The results are presented as odds ratios (OR) with 95% confidence intervals (CI) and p-values. All data processing was conducted using IBM SPSS Statistics 22. This study also have an ethical approval which is publication by Ethical Committee of Faculty of Health Science UIN Syarif Hidayatullah Jakarta with the ethichal approval code Un.01/F.10/KP/01/1/KE.SP/05.08.017/2025.

Results

Table 1. Prevalence of Low Birth Weight in Indonesia

Low Birth Weigh	n	%
Yes LBW (< 2.500 grams)	2.043	5,7
No LBW ($\geq$ 2.500 grams)	35.150	94,3
Total	37.193	100

Based on the 2023 Indonesia Health Survey, the prevalence of low birth weight among infants was 5,7% (n = 2.043), while 94,3% (n = 35.150) had a birth weight of $\geq$ 2.500 grams. Table 1 shows that the prevalence of low birth weight (LBW) in Indonesia was 5.7% (n = 2,043), while 94.3% (n = 35,150) of infants were born with a birth weight of $\geq$ 2.500 grams. Although the majority of infants were born with normal birth weight, LBW remains an important public health concern due to its association with increased risks of neonatal morbidity, mortality, and adverse health outcomes later in life. The prevalence observed in this study was slightly lower than the national LBW prevalence reported in the 2023 Indonesia Health Survey (6.2%). This difference may be attributed to variations in sample characteristics and inclusion criteria used in the analysis.

Table 2. Descriptive characteristics of respondents and LBW determinants in Indonesia

Variable	Low Birth Weight				Total	
	Yes		No		n	%
	n	%	n	%		
Maternal Characteristics						
Maternal age at delivery						
At risk (< 20 or > 35 years)	623	7,0	8.805	93,0	9.428	100
Not at risk (20 - 35 years)	1.420	5,4	26.345	94,6	27.765	100
Maternal education						
No schooling	37	5,3	529	94,7	566	100
Primary	457	6,5	6.491	93,5	6.948	100
Secondary	1.153	5,4	21.205	94,6	22.358	100
Higher	396	6,4	6.925	93,6	7.321	100
Maternal Occupation						
Heavy work	133	5,5	2.669	94,5	2.802	100
Moderate work	409	5,4	7.654	94,6	8.063	100
Light work	1.501	5,9	24.827	94,1	26.328	100

Variable	Yes		No		Total	
	n	%	n	n	%	n
Smoking status						
Active smoker	8	6,8	157	93,2	165	100
Passive smoker	1.386	5,8	24.257	94,2	25.643	100
Non smoker	649	5,5	10.736	94,5	11.385	100
ANC visits						
< 6 times	742	6,5	11.579	93,5	12.321	100
≥ 6 times	1.301	5,5	23.571	94,5	24.872	100
Anemia status						
Yes	82	7,4	1.269	92,6	1.351	100
No	1.961	5,7	33.881	94,3	35.842	100
Maternal height						
< 150 cm	776	8,0	9.317	92,0	10.093	100
≥ 150 cm	1.267	4,9	25.833	95,1	27.100	100
Hypertension status						
Yes	219	13,6	1.307	86,4	1.526	100
No	1.824	5,4	33.843	94,6	35.667	100
Infant Characteristics						
Premature birth						
Yes (< 37 weeks)	722	26,0	2.865	74,0	3.587	100
No (≥ 37 weeks)	1.321	3,9	32.285	96,1	33.606	100
Infant sex						
Female	1.114	6,4	16.808	93,6	17.922	100
Male	929	5,2	18.342	94,8	19.271	100
Birth type						
Twin	174	51,1	190	48,9	364	100
Singleton	1.869	5,2	34.960	94,8	36.829	100
Environmental Characteristics						
Residence						
Rural	901	5,3	15.687	94,7	16.588	100
Urban	1.142	6,1	19.463	93,9	20.605	100
Socioeconomic status						
Very poor	474	6,5	6.806	93,5	7.280	100
Poor	391	5,3	6.983	94,7	7.374	100
Middle	492	5,5	8.988	94,5	9.480	100
Rich	327	5,6	5.618	94,4	5.945	100
Very rich	359	5,9	6.755	94,1	7.114	100

The distribution of Low Birth Weight was analyzed according to maternal, infant, and environmental characteristics. Table 2 presents the distribution of low birth weight (LBW) according to maternal, infant, and environmental characteristics. Higher proportions of LBW were observed among mothers at high-risk ages (< 20 or > 35 years) (7.0%), mothers with primary education (6.5%), active smokers (6.8%), mothers with fewer than six antenatal care visits (6.5%), mothers with anemia (7.4%), mothers with a height of <150 cm (8.0%), and mothers with hypertension (13.6%). Among infant characteristics, LBW was more common among preterm infants (26.0%), female infants (6.4%), and twins (51.1%) than their respective counterparts. Regarding environmental factors, the proportion of LBW was slightly higher among urban residents (6.1%) and among infants from very poor

households (6.5%). These findings suggest that maternal, infant, and environmental factors may contribute to variations in LBW occurrence in Indonesia. Detailed distribution of Low Birth Weight cases by maternal, infant, and environmental characteristics are presented in Tables 2.

Table 3. Final model of multivariate logistic regression of LBW determinants in Indonesia

Variable	Low Birth Weight				Adj odds ratio	95% CI	p-value
	Yes		No				
	n	%	n	%			
Maternal Age at Delivery							
At risk (< 20 or > 35 years)	623	7,0	8.805	93,0	1,262	1,059 - 1,053	0,009
Not at risk (20 - 35 years)	1.420	5,4	26.345	94,6		ref	
Maternal Height							
< 150 cm	776	8,0	9.317	92,0	1,661	1,416 - 1,950	0,000
≥ 150 cm	1.267	4,9	25.833	95,1		ref	
Hypertension Status							
Yes	219	13,6	1.307	86,4	2,503	1,935 - 3,236	0,000
No	1.824	5,4	33.843	94,6		ref	
Preterm Birth							
Yes (< 37 weeks)	722	26,0	2.865	74,0	7,822	6,574 - 9,308	0,000
No (≥ 37 weeks)	1.321	3,9	32.285	96,1		ref	
Infant Sex							
Female	1.114	6,4	16.808	93,6	1,376	1,179 - 1,605	0,000
Male	929	5,2	18.342	94,8		ref	
Birth Type							
Twin	174	51,1	190	48,9	14,805	9,584 - 22,869	0,000
Singleton	1.869	5,2	34.960	94,8		ref	

The final model included six significant predictors of Low Birth Weight. The adjusted odds ratio (AOR) are presented in Table 3. The final multivariable logistic regression model identified six significant determinants of low birth weight (LBW) in Indonesia, namely maternal age at delivery, maternal height, hypertension status, preterm birth, infant sex, and birth type. Among these factors, twin birth emerged as the strongest predictor of LBW, followed by preterm birth and maternal hypertension. Maternal characteristics, including age at delivery and height, also remained significantly associated with LBW after adjustment for other covariates. In addition, female infants were more likely to be born with LBW than male infants. These findings suggest that the occurrence of LBW is influenced by a combination of maternal, pregnancy-related, and infant-related factors, highlighting the multifactorial nature of LBW. Therefore, efforts to reduce the burden of LBW in Indonesia should adopt a comprehensive approach that includes improving maternal health and nutrition, preventing and managing pregnancy complications, and strengthening antenatal care services to support optimal fetal growth and development.

Discussion

The analysis revealed a low birth weight (LBW) prevalence of 5.7% in Indonesia, slightly lower than the national prevalence of 6.2% reported by the 2023 Indonesia Health Survey. This difference may be attributed to the specific characteristics of the study sample, which can influence prevalence estimates. Nevertheless, the findings indicate that LBW remains an important public health concern requiring continued efforts to improve maternal and child health outcomes. Beyond its association

with neonatal morbidity and mortality, LBW has also been linked to long-term metabolic disorders, including obesity. The fetal programming hypothesis suggests that intrauterine nutritional deprivation induces metabolic adaptations that increase susceptibility to obesity and other metabolic diseases later in life (28).

Maternal Age at Delivery

Maternal age at delivery was significantly associated with low birth weight (LBW) in this study (AOR = 1.262), indicating that mothers in the high-risk age group (< 20 years or > 35 years) were more likely to deliver LBW infants than those aged 21 - 35 years. The increased risk among younger mothers may be explained by the biological immaturity of the reproductive system, which can limit the mother's capacity to support optimal fetal growth. In addition, adolescent mothers are often still undergoing physical growth, creating competition for nutrients between maternal development and the growing fetus. This condition may compromise fetal growth and increase the risk of preterm birth and LBW (21); (9). Conversely, advanced maternal age (> 35 years) is associated with declining reproductive function, reduced placental efficiency, and an increased risk of pregnancy complications, such as hypertension, preeclampsia, and gestational diabetes. These conditions may impair uteroplacental blood flow and restrict fetal growth, thereby increasing the likelihood of LBW (7); (9). These findings highlight the importance of age-specific interventions across the reproductive life course. Preventing adolescent pregnancy through reproductive health education and improved access to youth-friendly reproductive health services may help reduce LBW risk among younger mothers. Meanwhile, strengthening preconception care and antenatal monitoring for women of advanced maternal age is essential for the early detection and management of pregnancy-related complications that may adversely affect birth outcomes.

This finding is also consistent with the Islamic principle of protecting offspring (hifzh al-nasl), as emphasized in QS. Luqman verse 14, which highlights the hardship experienced by mothers during pregnancy. Therefore, maintaining maternal health through appropriate reproductive planning and antenatal care represents an effort to protect both maternal and fetal well-being.

Maternal Height

Maternal height was significantly associated with low birth weight (LBW) in this study. Although most mothers had a height of ≥ 150 cm, the proportion of LBW was higher among mothers with a height of < 150 cm (8.0%) compared to those with a height of ≥ 150 cm (4.9%). This finding is consistent with the study by Inoue et al. (12), which reported that shorter maternal stature is associated with an increased risk of delivering LBW infants.

This association may be explained by several biological and socioeconomic mechanisms. Short maternal stature often reflects the cumulative effects of chronic undernutrition and adverse environmental conditions experienced throughout childhood and adolescence. These conditions may impair a woman's physiological capacity to support optimal fetal growth and development during pregnancy. In addition, shorter mothers are more likely to have smaller pelvic dimensions and restricted intrauterine space, which may limit fetal growth and increase the risk of LBW (12). Therefore, maternal height should not be viewed merely as a physical characteristic but also as a cumulative indicator of nutritional status, health conditions, and socioeconomic circumstances across the life course (28).

The findings highlight the importance of adopting a life-course approach to LBW prevention. Nutritional interventions should begin early in life, particularly among girls and adolescent females, through programs aimed at improving nutritional status, providing micronutrient supplementation, and preventing stunting to ensure optimal growth into adulthood. Furthermore, continuous nutrition education for women of reproductive age and pregnant women is essential to promote adequate nutrient intake during pregnancy, support healthy fetal growth, and reduce the risk of LBW.

Hypertension Status

Maternal hypertension was significantly associated with low birth weight (LBW) in this study (AOR = 2.503; 95% CI: 1.935 - 3.236), indicating that mothers with hypertension during pregnancy were 2.5 times more likely to deliver LBW infants than those without hypertension. The proportion of LBW was also substantially higher among hypertensive mothers (13.6%) compared with non-hypertensive mothers (5.4%). This finding is consistent with previous studies reporting maternal hypertension as an important risk factor for LBW (Kurniawati et al., 2023; Trisia et al., 2023).

The association may be explained by impaired uteroplacental circulation resulting from elevated maternal blood pressure. Hypertensive disorders during pregnancy are characterized by abnormal placental development and endothelial dysfunction, which reduce placental perfusion and restrict the delivery of oxygen and essential nutrients to the fetus (13); (22). Inadequate oxygen supply impairs fetal energy production, while insufficient nutrient transfer limits fetal growth and development, thereby increasing the risk of intrauterine growth restriction and LBW (27). These findings highlight the importance of strengthening antenatal care services through routine blood pressure screening, early detection, and appropriate management of hypertensive disorders during pregnancy. Furthermore, integrated clinical protocols and timely referral systems are essential to minimize adverse birth outcomes associated with maternal hypertension.

From an Islamic perspective, the prevention and management of maternal hypertension reflect the principle of *hifzh al-nafs* (preservation of life), as emphasized in the Prophetic teaching “There should be neither harming nor reciprocating harm” (HR. Ibn Majah No. 2340). Therefore, early detection and appropriate management of pregnancy complications represent an effort to protect both maternal and fetal health.

Preterm Birth

Preterm birth was a strong and significant predictor of low birth weight (LBW) in this study (AOR = 7.822; 95% CI: 6.574 - 9.308), indicating that preterm infants were nearly eight times more likely to be born with LBW than term infants. Consistent with this finding, the proportion of LBW was substantially higher among preterm infants (26.0%) compared with term infants (3.9%). This finding is in line with previous studies reporting a significant association between preterm birth and LBW (25).

The association is biologically plausible because fetal weight increases progressively with gestational age, particularly during the third trimester when rapid fetal growth occurs. Infants born before 37 weeks of gestation have less time to complete intrauterine growth and organ development, resulting in lower birth weight at delivery (29). Furthermore, preterm infants often have immature organ systems and limited nutritional reserves, which contribute to poor growth outcomes and adverse neonatal prognosis (23); (26). Consequently, shortened gestational duration restricts fetal growth potential and substantially increases the risk of LBW.

These findings highlight the importance of preventing preterm birth through improved preconception and antenatal care. Strategies such as achieving optimal nutritional status, maintaining a healthy pre-pregnancy weight, avoiding smoking, and effectively managing pre-existing medical conditions before and during pregnancy may help reduce the risk of preterm delivery and improve birth outcomes.

Infant Sex

Infant sex was significantly associated with low birth weight (LBW) in this study (AOR = 1.376; 95% CI: 1.246 - 1.519), with female infants exhibiting a higher risk of LBW than male infants. Consistent with this finding, the proportion of LBW was higher among female infants (6.4%) than among male infants (5.2%). This result is in line with previous studies reporting a significant association between

infant sex and birth weight outcomes, with male infants generally being born 100 - 200 grams heavier than female infants on average (29).

Biological differences in fetal development may partially explain this association. Sex differentiation begins at the chromosomal level, where male fetuses (XY) express the SRY gene, triggering testicular development and testosterone production. Testosterone and other androgens play important roles in regulating cell growth, metabolism, and fetal development. In contrast, female fetuses (XX), which lack the SRY gene, develop under different hormonal influences, particularly estrogen and progesterone, which may affect fetal growth regulation and responses to intrauterine stress (10). Furthermore, Y chromosome-linked growth-related genes may provide male fetuses with a relative growth advantage, contributing to higher birth weights compared with female fetuses (1); (36).

Although infant sex is a non-modifiable characteristic, the findings underscore the importance of ensuring adequate maternal nutrition and high-quality antenatal care to support optimal fetal growth regardless of fetal sex.

Birth Type

Birth status was found to be a strong and significant determinant of LBW with an AOR of 14.805, meaning that babies born with twins have a 14.805 times greater chance of experiencing LBW. Fetal weight in twin births is lighter than fetuses born with singleton births. The average weight of a fetus born with twins is 1,000 grams lighter than that of a singleton birth (Indah et al, 2020). Twin pregnancies, especially monochorionic diamniotic pregnancies, carry a higher risk of complications such as Twin-to-Twin Transfusion Syndrome (TTTS). TTTS occurs in 10-15% of these pregnancies, caused by an abnormal connection of the placental blood vessels that causes unequal blood flow. The donor twin experiences hypovolemia and oligohydramnios, while the recipient twin can experience hypervolemia and cardiac overload (30).

In addition, twin pregnancies are more susceptible to preeclampsia and intrauterine growth restriction (IUGR). A 1% increase in twin births has been shown to contribute to a 0.495% increase in the incidence of low birth weight (LBW) (6); (33). This is likely due to increased placental mass and vascular surface area, which increases vascular resistance and oxidative stress. Furthermore, uncoordinated fetal growth is common in twin pregnancies, increasing the risk of adverse outcomes such as low birth weight (24).

Intervention that can be carried out based on the findings in this study are to provide more intensive and focused antenatal care for twin pregnancies, including monitoring fetal growth.

Research Limitations

This study has several limitations that should be considered when interpreting the findings. One limitation is that the analysis did not account for variations in LBW risk across provinces in Indonesia. Each region may have distinct characteristics, including socioeconomic conditions, healthcare accessibility, maternal healthcare quality, and environmental factors that may influence LBW occurrence. Therefore, this study could not fully capture province-specific patterns of LBW determinants. Further studies incorporating regional contextual factors or multilevel analytical approaches are needed to provide a more comprehensive understanding analytical approaches are needed to provide a more comprehensive understanding of variations in LBW risk across Indonesia.

Conclusion

The analysis results indicate that several determinants are associated with the incidence of LBW, namely maternal age at delivery, maternal height, hypertension status during pregnancy, premature birth, infant sex, and birth status. The strongest determinant is twin/multiple birth status. These findings confirm that the incidence of LBW is multifactorial, influenced by maternal factors (age, height, nutritional status, hypertension), pregnancy factors (prematurity, multiple pregnancies), and

fetal biological factors (gender). Therefore, efforts to prevent LBW require a comprehensive approach that includes nutritional interventions from childhood and adolescence, reproductive health education, improving the quality of preconception and antenatal care, and intensive monitoring of high-risk pregnancies.

Acknowledgment

The authors would like to express their gratitude to the Indonesian Ministry of Health and the Central Bureau of Statistics for providing access to the 2023 Indonesia Health Survey (IHS) data used in this study. Appreciation is also extended to all individuals and institutions who contributed to the completion of this research, either directly or indirectly. During the preparation of this manuscript, ChatGPT was used as a writing assistance tool for language editing, improving sentence structure, paraphrasing, and organizing the presentation of information. The authors critically reviewed, verified, and revised all AI-assisted content and remain fully responsible for the accuracy, integrity, and originality of the manuscript.

Conflict of Interest

The authors declare that they have no competing interest. All data used in this study were obtained from the 2023 Indonesia Health Survey conducted by the Ministry of Health of Indonesia. The dataset is publicly available upon request from the official repository of Indonesia Health Survey.

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