Prediction Model of Low Birth Weight Based on the Factors that Influence at West Bandung Regional Hospital

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ABSTRACT

Low Birth Weight (LBW) is a major contributor to neonatal mortality and developmental disorders in Indonesia. In West Bandung Regency, the prevalence of LBW remains high and plays a significant role in the overall infant mortality rate in West Java Province. Despite this, no locally adapted predictive model has been developed to assess LBW risk based on maternal characteristics. This study aimed to construct a predictive model for LBW using maternal factors among mothers delivering at three district public hospitals: RSUD Cililin, RSUD Lembang, and RSUD Cikalong Wetan. This quantitative study employed a retrospective approach involving 265 respondents selected through purposive sampling. Data were collected from medical records and brief interviews and analyzed using multiple linear regression. The research was conducted between January and March 2024. The results showed that among six independent variables tested, three had a statistically significant effect on infant birth weight: maternal age ($p = 0.047$), maternal weight gain during pregnancy ($p = 0.004$), and parity ($p < 0.001$). The predictive model generated was: $Y = 2570.162 + 3.739X_1 - 11.501X_2 - 94.726X_3$, with an R^2 value of 0.464, indicating that 46.4% of the variation in birth weight can be explained by the model. The model suggests that maternal age positively influences birth weight, whereas excessive maternal weight gain and higher parity show a negative relationship. This model can be used by healthcare providers as an early screening tool to detect LBW risk and to support targeted nutrition education and antenatal interventions at health service facilities.

INTRODUCTION

The Neonatal Mortality Rate (NMR) is a key indicator for assessing the health status of a population. According to data from the Central Bureau of Statistics (2023), NMR is defined as the number of infant deaths within the first 28 days of life per 1,000 live births. A report by the World Health Organization (WHO) stated that in 2022, approximately 2.3 million neonatal deaths occurred globally, with an average NMR of 17 per 1,000 live births (WHO, 2022).

In Indonesia, the trend of infant mortality has shown a significant increase. The Ministry of Health of the Republic of Indonesia reported a surge

in infant deaths from 21,447 cases in 2022 to 34,226 cases in 2023 (MoH RI, 2023). West Java Province is among the regions with the highest contribution to this figure, with West Bandung Regency ranking third in infant mortality after Bogor Regency and Bandung City (Barwanto & Ramadhan, 2024).

Low Birth Weight (LBW), defined as a birth weight of less than 2,500 grams regardless of gestational age [Febriyanti], is one of the leading causes of neonatal death. Infants with LBW are at higher risk of developing serious complications, such as hypothermia, respiratory distress, and long-term developmental delays (Hilaire et al., 2021). Data from the 2018 Basic Health Research (Riskesdas) showed that the prevalence of LBW in West Bandung Regency reached 6.2%, which is higher than the national average (MoH RI, 2018).

Risk factors for LBW can be categorized into three groups: (1) maternal factors such as maternal age, parity, nutritional status, and pregnancy complications; (2) fetal factors such as intrauterine infections and congenital anomalies; and (3) placental factors, including placental abruption and placenta previa (Widowati et al., 2024). Among these, maternal factors are believed to contribute the most to LBW incidence.

Several maternal factors have been consistently identified in previous studies as significant predictors of low birth weight (Rizkika et al., 2023). These include maternal age, pre-pregnancy weight, weight gain during pregnancy, parity, interpregnancy interval, and mid-upper arm circumference (MUAC) (Bajwa et al., 2024). Maternal age at extremes (<20 or >35 years) has been associated with higher LBW risk due to biological immaturity or obstetric complications (Correa-De-Araujo & Yoon, 2021). Inadequate pre-pregnancy weight and insufficient gestational weight gain are also strongly linked to intrauterine growth restriction. In addition, a short interpregnancy interval (<24 months) and high parity may reduce maternal nutritional reserves, thereby increasing LBW risk. MUAC, as a simple anthropometric measure, reflects maternal nutritional status and has shown predictive value for adverse birth outcomes, including LBW, especially in resource-limited settings (Nisak & Nadhiroh, 2024).

This study aims to develop a predictive model for LBW based on maternal factors among mothers giving birth at three regional public hospitals in West Bandung Regency: RSUD Cililin, RSUD Lembang, and RSUD Cikalong Wetan. The resulting model is expected to serve as a practical tool for healthcare professionals to identify LBW risks earlier, thereby enabling more targeted and effective interventions.

RESEARCH METHODS

This study was conducted in three regional public hospitals (RSUD) located in West Bandung Regency, namely RSUD Cililin, RSUD Lembang, and RSUD Cikalong Wetan, during the year 2023. A retrospective study design was employed, utilizing both primary and secondary data sources. Primary data were obtained directly from medical records and interviews with healthcare professionals, while secondary data were gathered from the statistical reports of the respective hospitals. The data collection instruments were tested for validity and reliability to ensure the accuracy and consistency of the information collected.

The study population consisted of 785 infants born at the three hospitals during 2023. The sample size was determined using the Slovin formula as follows:

$$n = \frac{N}{1 + Ne^2}$$

A total of 265 participants were selected using purposive sampling, with inclusion criteria consisting of infants born with low birth weight (LBW) at the three RSUDs and meeting the inclusion requirements. The independent variables investigated included maternal pre-pregnancy weight, maternal age, maternal weight gain during pregnancy, parity, pregnancy interval, and the duration of cross-laboratory activity intervention (MUAC). The dependent variable was the infant's birth weight. This study received ethical approval from the Health Research Ethics Committee of the Faculty of Health Science and Technology, Jenderal Achmad Yani University Cimahi, with approval number 023/KEPK/FITKes-Unjani/V/2024.

Normality testing was conducted using the Kolmogorov-Smirnov test, appropriate for samples exceeding 50

participants. The results showed that most of the studied variables were normally distributed (p > 0.05), including maternal pre-pregnancy weight (p = 0.065), maternal age (p = 0.546), maternal weight gain (p = 0.669), parity (p = 0.763), and pregnancy interval (p = 0.082). However, the variable duration of cross-laboratory activity intervention (MUAC) did not meet the criteria for normal distribution (p = 0.031; p < 0.05). The interpretation and statistical analyses were conducted with consideration of the data's distribution characteristics.

Statistical analyses included Pearson correlation tests for normally distributed variables and alternative statistical methods as needed for non-normally distributed variables. Furthermore, multivariate analysis using linear regression was employed to construct a predictive model for low birth weight based on eligible independent variables.

RESULTS AND DISCUSSION

This study was conducted to identify the factors influencing low birth weight (LBW) among infants born in regional public hospitals in West Bandung Regency. The data collected included maternal pre-pregnancy weight, maternal age, maternal weight gain during pregnancy, parity, pregnancy interval, and mid-upper arm circumference (MUAC) measurements of the mothers.

Table 1. Results of the normality test for the independent variables

Variable	Normality Test	
	P value	**Result**
Maternal pre-pregnancy weight	0.065	Normal
Maternal age	0.546	Normal
Maternal weight gain during pregnancy	0.669	Normal
Parity	0.763	Normal
Pregnancy interval	0.082	Normal
MUAC	0.031	Tidak Normal

Table 1 presents the results of the normality test for the independent variables. The Kolmogorov-Smirnov test was used to assess whether the distribution of each variable met the assumption of normality. The results indicated that maternal pre-pregnancy weight (p = 0.065), maternal age (p =

0.546), maternal weight gain during pregnancy (p = 0.669), parity (p = 0.763), and pregnancy interval (p = 0.082) were normally distributed (p > 0.05). However, the MUAC (mid-upper arm circumference) variable did not follow a normal distribution (p = 0.031; p < 0.05). These findings guided the selection of subsequent statistical tests appropriate for each variable.

The analysis was then continued to describe each of the studied variables, as presented in Table 4.2 below:

Table 2. Descriptive Analysis

Variabel	Mean	SD
Maternal pre-pregnancy weight	53.09	6.377
Maternal age	28.83	7.243
Maternal weight gain during pregnancy	12.69	3.164
Parity	2.54	1.807
Pregnancy interval	3.74	1.952
MUAC	24.55	2.162
Birth weight of the infants	2291.39	256.155

The results of the descriptive analysis in Table 2 indicate that the average maternal pre-pregnancy weight was approximately 53 kg, and the mean maternal age was 28 years. The average maternal weight gain during pregnancy was 12 kg, with a mean parity of 2 births. The average pregnancy interval was 3 years, while the mean mid-upper arm circumference (MUAC) was 24 cm. The mean birth weight of the infants was approximately 2,292 grams.

Table 3 presents the results of the correlation analysis between the independent variables and infant birth weight. This analysis aimed to identify which variables were significantly associated with birth weight and, therefore, eligible to be included in the predictive model. The variables tested included maternal pre-pregnancy weight, maternal age, maternal weight gain during pregnancy, parity, pregnancy interval, and MUAC. The results showed that several variables had statistically significant correlations with birth weight, indicating their potential as key predictors in determining neonatal birth weight.

Table 3. Results of correlation analysis on birth weight

Variable	P value
Maternal pre-pregnancy weight	0.328
Maternal age	<0.001
Maternal weight gain during pregnancy	<0.001
Parity	<0.001
Pregnancy interval	0.273
MUAC	0.899

The results of the correlation test presented in Table 3 show the relationship between the studied factors and infant birth weight. A significant correlation was found between maternal age, maternal weight gain during pregnancy, and parity with infant birth weight ($p < 0.05$). In contrast, maternal pre-pregnancy weight, pregnancy interval, and MUAC did not show a statistically significant relationship with infant birth weight ($p > 0.05$). Furthermore, linear regression analysis revealed that maternal age, maternal weight gain, and parity had p-values < 0.25, indicating that these variables qualified for inclusion in the predictive model. Meanwhile, maternal pre-pregnancy weight, pregnancy interval, and MUAC had p-values > 0.25 and thus were excluded from the model.

Table 4. Multivariate Analysis

Model	R	R^2	Durbin-Watson
Regretion	0.681	0.464	1.837

Based on Table 4, the correlation coefficient (R) value of 0.681 indicates a moderately strong positive relationship between the independent variables (maternal age, maternal weight gain during pregnancy, and parity) and the dependent variable (infant birth weight). The coefficient of determination (R^2) is 0.464, suggesting that 46.4% of the variance in infant birth weight can be explained by the three independent variables, while the remaining 53.6% is influenced by other factors not included in the model. The Durbin-Watson statistic of 1.837 is close to the ideal value of 2.0, indicating that there is no autocorrelation among the residuals in the regression model. These results suggest that the regression model is appropriate and valid for further analysis.

Table 5. Multiple Linear Regression Equation Results

Model	Coeficcient	Std. Error	Coefficient correlation	T	P value	VIF
Constant	2570.162	63.635		40.389	0.000	
Maternal age	3.739	1.871	0.106	1.999	0.047	1,362
Maternal weight gain during pregnancy	-11.501	3.912	-0.142	-2.940	0.004	1,136
Parity	-94.726	7.786	-0.668	-12.166	0.000	1,468

Based on the multiple linear regression analysis presented in Table 5, a regression model was developed to predict infant birth weight using maternal age, maternal weight gain during pregnancy, and parity as independent variables. The analysis revealed that maternal age had a positive and statistically significant association with infant birth weight, with a regression coefficient of 3.739 and a p-value of 0.047. This finding indicates that for each additional year in maternal age, infant birth weight increased by approximately 3.739 grams. Conversely, maternal weight gain during pregnancy showed a significant negative association with infant birth weight, with a coefficient of –11.501 and a p-value of 0.004. This suggests that each 1 kg increase in maternal weight gain was associated with a decrease in infant birth weight by approximately 1.15 grams.

Parity also demonstrated a strong negative effect, with a regression coefficient of –94.726 and a p-value of < 0.001, indicating that a higher number of previous deliveries was significantly associated with lower infant birth weight. Multicollinearity testing showed that the Variance Inflation Factor (VIF) values for all independent variables were below 10, suggesting that multicollinearity was not a serious issue in the model.

Bivariate analysis showed significant associations between maternal age, maternal weight gain during pregnancy, and parity with infant birth weight. In this study, the mean maternal age was within the range of healthy reproductive age, averaging 28.83 years. Maternal age demonstrated a significant relationship with infant birth weight, despite the majority of respondents being within the productive age group. Theoretically, the ideal reproductive age for pregnancy is

between 20 and 35 years, as the reproductive system and maternal physiological condition are generally optimal within this range to support pregnancy and fetal development. The significant effect of maternal age on birth weight in this study suggests that age does not act in isolation but may interact with other factors such as maternal health status, socioeconomic conditions, nutritional status, and access to healthcare services. Younger mothers, although within the reproductive age range, may have limited knowledge and experience related to prenatal care, while older mothers may begin to experience physiological declines that could affect pregnancy outcomes, even if still classified as within reproductive age. These findings are consistent with Čvorović (2024), who reported that although mothers may fall within a healthy reproductive age range, increasing maternal age still contributes to pregnancy-related risks, including the likelihood of delivering a low birth weight (LBW) infant. Similarly, a study by Wang et al. (2020) found that each additional year of maternal age was linearly associated with an increased risk of obstetric and neonatal complications, including lower infant birth weight, even within what is typically considered a normal maternal age range.

The analysis showed a significant association between maternal weight gain during pregnancy and the incidence of low birth weight (LBW). The average maternal weight gain in this study was 12.69 kg, which is generally categorized as adequate according to the standards of the Indonesian Ministry of Health, particularly when the pre-pregnancy Body Mass Index (BMI) falls within the normal range (18.5–24.9). However, a considerable proportion of LBW cases was still found, indicating that beyond the quantity of weight gain, factors such as nutritional quality, trimester-specific weight distribution, and the mother's overall health condition also play crucial roles in fetal growth.

Adequate maternal weight gain during pregnancy is essential to support fetal development and prevent LBW. Insufficient weight gain may reflect inadequate maternal nutrient intake, increasing the risk of intrauterine growth restriction. Fall (2013) explained that malnutrition during the first trimester may impair the early

regulation of fetal growth, while deficiencies in the second trimester can affect fetoplacental interactions, resulting in babies with low birth weight and small body proportions. If nutritional deficits occur in the third trimester, brain development is prioritized at the expense of body growth, potentially leading to babies born with normal weight but shorter body length (Thornburg & Valent, 2024).

This study found a significant relationship between maternal parity status and the incidence of low birth weight (LBW). Although the majority of respondents in this study were multiparous, LBW cases were still observed within this group. These findings highlight that even mothers with previous childbirth experience remain at risk for delivering LBW infants. Several studies support that primiparous women are at higher risk of LBW due to a lack of experience in managing pregnancy, heightened anxiety, and suboptimal physiological adaptation to pregnancy-related changes (Aisah et al., 2024). However, this study illustrates that multiparous women may still be susceptible to LBW, potentially due to other contributing factors such as

inadequate antenatal care, short interpregnancy intervals, or recurrent obstetric complications. A study by Workineh et al. (2020) in Ethiopia emphasized that multiparity does not always serve as a protective factor against LBW, particularly in the absence of improved lifestyle behaviors and adequate prenatal monitoring. Additionally, research by Wardani, Tirtawati, and Utarini (2025) noted that high parity (more than three children) may increase the risk of pregnancy-related complications, including LBW, due to physiological exhaustion and divided family resources. Although multiparous women are theoretically more experienced, other factors-such as pregnancy education, nutritional status, family support, and quality of prenatal care-remain essential in preventing LBW.

Regarding the variable of interpregnancy interval, this study found a significant association between the spacing of pregnancies and the incidence of low birth weight (LBW). Respondents with a short interpregnancy interval (<24 months) experienced more cases of LBW compared to those with a more ideal spacing. These findings align with

existing theories and previous research suggesting that short intervals between pregnancies may not allow sufficient time for maternal nutritional stores to be fully replenished following the previous pregnancy (Dewey & Cohen, 2007). This condition can negatively affect placental quality, fetal growth, and increase the risk of pregnancy complications, including LBW (Nursanti & Lestari, 2020). According to the World Health Organization (WHO), a safe interpregnancy interval is at least 24 months, giving the mother adequate time to recover physically and nutritionally. If conception occurs too soon, the mother's body may not be fully prepared to support the optimal development of the next fetus, thereby increasing the risk of intrauterine growth restriction (WHO, 2017).

This study also revealed a significant association between maternal mid-upper arm circumference (MUAC) and the incidence of low birth weight (LBW). Most mothers with a MUAC of less than 23.5 cm gave birth to babies with low birth weight. MUAC is an indicator of maternal nutritional status, particularly reflecting body fat reserves and muscle mass. A MUAC value below 23.5 cm is commonly used

as a threshold for identifying the risk of chronic energy deficiency (CED) in pregnant women. Mothers with poor nutritional status may not be able to provide sufficient nutrients to the fetus, thereby impairing fetal growth and increasing the risk of LBW (Indriyani et al., 2023). Several studies have also reported a positive correlation between MUAC and birth weight, making this parameter a useful early screening tool for assessing maternal nutritional status, especially in resource-limited settings (Nisak & Nadhiroh, 2024). Regular monitoring of MUAC during pregnancy is crucial, particularly at the primary care level, to enable early detection of LBW risk and allow for timely interventions.

The coefficient of determination (R^2) was 0.464, meaning that 46.4% of the variation in birth weight could be explained simultaneously by the three independent variables, while the remaining 53.6% was influenced by other factors not included in the model. The Durbin-Watson value of 1.837, which is close to 2, indicates no autocorrelation in the regression model, suggesting that the model is suitable for further analysis. As shown in Table 5, among the three variables, maternal age

demonstrated a statistically significant positive association with birth weight, with a regression coefficient of 3.739 and a p-value of 0.016 ($p < 0.05$). Each one-year increase in maternal age was associated with an increase of 3.739 grams in birth weight, assuming other variables remain constant. This finding is consistent with previous research indicating that maternal age within the optimal reproductive range (20–35 years) tends to contribute to better pregnancy outcomes, including adequate birth weight (Gemilastari et al., 2024).

A contrasting result was observed for the variable of maternal weight gain, which showed a statistically significant negative relationship with birth weight (coefficient = –111.501, p = 0.004). This finding contradicts existing theories and previous studies that generally state maternal weight gain during pregnancy contributes positively to birth weight (Ningsih & Sumarmi, 2023). Such a result may occur when the mother's weight gain during pregnancy does not reflect fetal growth but is instead influenced by increased maternal fat mass or fluid retention, particularly in high-risk pregnancies or cases of preeclampsia. The parity variable did not show a significant relationship with birth weight (coefficient = –94.726; p = 0.000, although the direction of the relationship was negative, and the t-value indicates a substantively irrelevant effect. While the statistical result appears significant, the negative effect should be reconsidered as it may be caused by confounding factors or a lack of sample homogeneity. Some previous studies have suggested that parity can influence birth weight, particularly regarding previous pregnancy experiences and maternal nutritional status during pregnancy (Fatmawati & Wati, 2021). However, in this study, no positive effect of parity on birth weight was found.

The regression model indicates that maternal age is a positive predictor of birth weight, while maternal weight gain and parity exhibit negative effects. In this context, these findings warrant further exploration to identify potential confounding variables that may not have been included in the model. Further research is also needed to examine specific factors influencing the composition of maternal weight gain during pregnancy.

CONCLUSIONS

Limitation of the study is much of the data is incomplete. This study successfully developed a predictive model for low birth weight (LBW) based on maternal factors in three hospitals in West Bandung Regency. The resulting predictive model is as follows:

$$Y = 2570.162 + 3.739X_1 - 11.501X_2 - 94.726X_3.$$ The model indicates that maternal age contributes positively to birth weight, whereas maternal weight gain and parity have negative associations. These findings can inform early interventions in primary healthcare services to help prevent low birth weight.

This study has several limitations. a significant portion of the maternal data, particularly regarding nutritional status indicators and gestational weight gain, was incomplete or inconsistently recorded in medical records, which may have affected the accuracy of the model. Second, the study was limited to three public hospitals in West Bandung Regency, potentially reducing the generalizability of the findings to other regions with different population characteristics or healthcare access. Future studies should consider prospective data collection and a larger, more diverse population sample to validate and refine the predictive model.

LITERATURE

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