Maternal Factors Influencing Low Birth Weight in Newborns: A Retrospective Study

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ABSTRACT

Background: *Birth weight is a critical indicator of an infant's health. Research conducted in Indonesia has identified low birth weight (LBW) as a leading cause of neonatal mortality, accounting for approximately 35% of all cases. This study aims to determine the factors influencing the incidence of LBW.*

Method: *The study used a retrospective design and included 83 respondents selected through quota sampling. Data were collected from the Maternal and Child Health (MCH) handbooks at Manggis Integrated Service Post (posyandu). Univariate analysis was performed to calculate frequency and percentage values. Bivariate analysis was carried out using the chi-squared test to examine relationships between variables. Multivariate analysis was conducted using the logistic regression test to assess the influence of multiple variables.*

Result: *Maternal age at pregnancy (p=0.037) and maternal mid-upper arm circumference (MUAC) (p=0.034) were significantly associated with the occurrence of LBW in newborns. The odds ratio (OR) analysis revealed MUAC as the primary factor influencing LBW (OR=4.278), followed by maternal age during pregnancy (OR = 3.750). In comparison, haemoglobin levels (p = 0.500), maternal height (p = 0.408), and gestational age (p=0.118) were not significantly associated with the occurrence of LBW. MUAC was found to influence the occurrence of LBW in Kemuning Lor Village (p = 0.027). The MUAC variable accounted for 16.9% of the variance in LBW cases (R2 = 0.169). Improving the nutritional status of adolescent girls is imperative to ensure optimal health outcomes in future pregnancies.*

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INTRODUCTION

Birth weight is a consistently recorded anthropometric measure in infants.(1) According to the World Health Organisation (WHO), birth weight can serve as a useful indicator for categorising infants as either low birth weight (LBW) or not. Specifically, LBW infants are defined as having a birth between 1,500 g and 2,499 g, whereas those with a birth weight between 2,500 g and 3,999 g are considered to have a normal birth weight. Birth weight plays a crucial role in the assessment of an infant's health, as it reflects their initial condition for growth and development and indicates their quality of life. It is suggested that LBW may reduce the likelihood of developing degenerative diseases in adulthood years.(2,3) LBW infants are particularly more vulnerable to infections and at a greater risk of complications. Infants born with a history of LBW has been associated with stunting during toddlerhood.(4) LBW has the potential to impede growth and development, thereby predisposing toddlers to stunting.(5)

Various factors have been found to influence birth weight, including maternal nutrition, physical condition (such as age during pregnancy and height), health status, employment, education, gestational age, pregnancy spacing, parity, and the occurrence of multiple pregnancies.(6)(7) The nutritional status of pregnant women is assessed through two key indicators: weight gain during pregnancy and mid-upper arm circumference (MUAC).(4)(8) Moreover, assessing haemoglobin (Hb) levels might provide insights into the nutritional health of pregnant women.(9) The presence of anaemia in pregnant women has been found to have detrimental effects on nutrition and uteroplacental oxygenation, ultimately leading to LBW infants.(9)(10) There is a correlation between maternal stature and pelvic width, with shorter mothers tending to have narrower pelves. This anatomical characteristic could impact the suitability of the uterus as an environment for foetal development, leading to LBW outcomes.(11) Women under 20 years or over 35 years are classified as high-risk age groups for delivering LBW infants.(2) In contrast, the age range of

20 to 35 years is considered ideal for pregnancy and childbirth since it falls within the category of a healthy reproductive age. Infants born prematurely, defined as those born before 37 weeks of gestation, was associated with an increased susceptibility to LBW due to the reduced period of intrauterine growth and weight gain.(12)

LBW is crucial in determining prenatal and neonatal mortality rates among infants aged 0-28 days.(13)(14) According to the Indonesian Demographic and Health Survey conducted by the Central Bureau of Statistics (2017), LBW accounted for the highest proportion of neonatal mortality in Indonesia, constituting 35% of all cases. Despite East Java having relatively low infant and neonatal mortality rates, data from the East Java Provincial Health Office (2022) reported 3,354 infant deaths in 2021, with 73.87% attributed to neonatal mortality.(15) The Family Health and Community Nutrition Section of the Jember Regency Health Office reported 356 LBW cases out of 8,037 newborns weighed in 2021, representing a prevalence of 23.3%. Data on the incidence of LBW in Jember Regency between 2017 and 2021 revealed that 2019 witnessed the highest proportion of LBW cases, with 5.54% of live births affected, while the lowest proportion was at 4.4% in 2021. The prevalence of LBW cases is significant both in Jember Regency and nationally, as reported by the Jember Regency Health Office in 2022.(15) Kemuning Lor, a village in Jember Regency, has been identified as the second highest in stunting prevalence in East Java, with a rate of 37.08%.(16) Furthermore, data from the profile of Kemuning Lor Village revealed stunting as a prominent issue encountered in the community.

The MCH handbook provides comprehensive information about the requirements and demands of expectant mothers, pregnancy, childbirth, postpartum, as well as the care and development of infants and toddlers. The handbook serves a resource for monitoring the health of pregnant women and the nutritional status of infants and toddlers. The handbook is also a valuable tool for identifying factors influencing LBW. According to the Ministry of Health of the Republic of Indonesia and JICA (2015), the use of the Maternal and Child Health handbook can effectively address maternal and child health issues, thereby reducing maternal and infant mortality rates. Given the aforementioned context, this study aims to investigate the determinants of LBW in Kemuning Lor Village. Specifically, this study focuses on examining haemoglobin (Hb) levels, MUAC, maternal height, maternal age at pregnancy, and gestational age to understand their impact on the occurrence of LBW. The primary objective of this study is to identify factors that contribute to LBW in the population of Kemuning Lor Village.

METHOD

This study employed a retrospective observational design conducted at integrated service posts (Posyandu) in Kemuning Lor Village, Jember Regency. The sample consisted of 556 children residing in Kemuning Lor Village and 83 mothers from five posyandu facilities: Manggis 14, Manggis 15, Manggis 16, Manggis 18, and Manggis 42. Participants were selected through the quota sampling method, where mothers visiting the posyandu during the data collection period were included until the target sample size of 83 was achieved. This study relied on secondary data extracted from the MCH handbook. The data provided information about the dependent variable (low birth weight) and independent variables such as haemoglobin (Hb) levels, maternal mid-upper arm circumference (MUAC), maternal height, maternal age at pregnancy, and gestational age. Univariate analysis was performed to calculate frequency and percentage values, bivariate analysis was carried out using the chi-squared test, and multivariate analysis was conducted using the logistic regression test.

RESULT AND DISCUSSION

Maternal Characteristics and LBW Incidence

This study employed univariate analysis to describe the independent variables, which included various maternal characteristics such as maternal haemoglobin levels, maternal height, maternal age at pregnancy, gestational age, and mid-upper arm circumference (MUAC). The dependent variable, LBW, was analysed using frequency distribution tables. Table 1 presents the results of the univariate analysis, including the frequency distribution of maternal characteristics and the incidence of LBW.

Table 1. Frequency distribution of maternal characteristics and the incidence of low birth weight

Variable	n	%
Haemoglobin levels		
Normal	60	72.3
Anaemia	23	27.7
Maternal height		
Non-Risk (≥145 cm)	79	96.3
Risky (<145 cm)	3	3.7
Maternal age at pregnancy		
20-35 years	68	81.9
<20 and >35 years	15	18.1
Gestational age		
Normal	62	76.5
Premature/postmature	19	23.5
MUAC		
Normal	61	73.5
Chronic energy deficiency	22	26.5
Birth weight		
Normal	70	84.3
Low (LBW)	13	15.7

This study used secondary data sources, specifically the MCH handbook, which had certain limitations regarding variable completeness. Notably, variables such as maternal height were found to be incomplete, with only 82 data points available. Similarly, maternal gestational age was found to be incomplete, with only 81 data points available. As shown in Table 1, the majority of women residing in Kemuning Lor Village (72.3%) had normal haemoglobin levels, while the remaining 27.7% were anaemic. In terms of maternal height, 96.3% of women were classified as having a non-risk height (≥145 cm), while only 3.7% fell into the risky height category (<145 cm). Additionally, over two-thirds of pregnant women in Kemuning Lor Village (81.9%) belonged to the healthy reproductive age group. In contrast, a smaller proportion of women fell into the at-risk reproductive age category, accounting for 18.1% of the total. Moreover, the majority of pregnant women in Kemuning Lor Village (76.5%) were within the average gestational age category, while the remaining 23.5% belonged to the premature/postmature group. Most women residing in Kemuning Lor Village (73.3%) had an average MUAC, while only 26.5% of pregnant women were found to have chronic energy deficiency (CED). Finally, the prevalence of LBW in Kemuning Lor Village was found to be 15.7%, whereas the majority of mothers (84.3%) delivered babies with a birth weight within the average range.

Determinants of LBW

Bivariate analysis was employed to establish the research hypothesis, specifically examining the potential associations between independent variables such as maternal haemoglobin levels, maternal height, maternal age during pregnancy, gestational age, and mid-upper arm circumference (MUAC), and the dependent variable, namely birth weight.

The findings presented in Table 2 indicated that maternal age during pregnancy and MUAC are factors that are significantly correlated with LBW in newborns. Crosstabulation analysis revealed that mothers within the reproductive age range of 20-35 years had a higher likelihood of delivering babies with average birth weights (88.2%) than those with low birth weights (11.8%). This finding is supported by hypothesis testing, which yielded a p-value of 0.037 ($p < 0.05$), indicating a statistically significant relationship between maternal age during pregnancy and the occurrence of LBW. Similarly, crosstabulation analysis revealed that mothers with an average MUAC had a higher likelihood of giving birth to babies with average birth weights (90.2%) compared to those with low birth weights (9.8%). Hypothesis testing yielded a p-value of 0.034 ($p < 0.05$), suggesting a statistically significant association between maternal MUAC and the occurrence of LBW. The most significant risk factor for LBW in Kemuning Lor Village, Jember Regency was identified as MUAC with an OR of 4.278, followed by maternal age during pregnancy with an OR of 3.750.

No association was observed between maternal factors such as haemoglobin levels, maternal height, and gestational age and the occurrence of LBW in Kemuning Lor Village. Crosstabulation analysis revealed that mothers who had normal haemoglobin levels were more likely to have infants with average birth weights (81.7%) than low birth weights (18.3%). However, hypothesis testing yielded a p-value of 0.500 ($p > 0.05$), indicating insufficient evidence to establish a relationship between

maternal haemoglobin levels and the occurrence of LBW. Similarly, mothers with a non-risk height (≥145 cm) showed a tendency to deliver infants with normal weights (84.8%) to those with low birth weights (15.2%). Hypothesis testing yielded a p-value of 0.408 (p > 0.05), suggesting no statistically significant association between maternal height and the occurrence of LBW. The average gestational age was associated with a higher proportion of normal-weight infants (90.3%) than low birth-weight infants (9.7%). However, hypothesis testing also yielded a p-value of 0.118 (p > 0.05), suggesting a lack of relationship between gestational age and the occurrence of LBW. Table 3 provides details on the correlation between maternal age, maternal MUAC, and the occurrence of LBW in Kemuning Lor Village, Jember Regency.

The findings presented in Table 3 indicated that MUAC was a significant determinant of LBW in newborns, as evidenced by a p-value of 0.027 (p < 0.05). This demonstrated a significant relationship between maternal MUAC and the occurrence of LBW in newborns. The incidence of LBW in newborns is influenced by MUAC and maternal age at pregnancy, with a coefficient of determination (R^2) of 0.169, which account for 16.9% of the variability in LBW cases. Furthermore, mothers with lower MUAC tended to have newborns with LBW, with a 4.203 times greater risk (ExpB = 4.203), than mothers with average MUAC.

The bivariate analysis revealed a significant correlation between maternal age during pregnancy and the occurrence of LBW in Kemuning Lor Village, as evidenced by a p-value of 0.037 (p < 0.05). This finding is consistent with the study conducted by Sembiring et al. (2019) at Mitra Medika General Hospital, Medan in 2017, which also demonstrated a correlation between maternal age during pregnancy and the occurrence of LBW in newborns, with a p-value of 0.000 (p < 0.05).(17) Similarly, the study conducted by Wahyuni et al. (2021) at Siti Fatimah Hospital in South Sumatra Province in 2020 yielded a p-value of 0.006 (p < 0.05).(18)

Mothers in the reproductive age associated with pregnancy can be categorised into three groups. The first group comprises individuals under 20 years, the second group consists of those aged 20-35 years, and the third group includes those who over 35 years. The optimal reproductive age range for women is considered to be between 20 and 35 years. Women in this age group are often regarded as having reached a sufficient level of physiological and psychological maturity.(19)(20)

Table 2. Factors Influencing the incidence of LBW

Independent Variable	Birth Weight				OR	95% CI
	Normal		LBW			
	n	%	n	%		
Haemoglobin levels						
Normal	49	81.7	11	18.3	0.500	0.086-2.082
Anaemia	21	91.3	2	8.7	0.424	
Maternal height						
Non-Risk (≥145 cm)	67	84.8	12	15.2	0.408	0.234-33.264
Risky (<145 cm)	2	66.7	1	33.3	2.792	
Maternal age at pregnancy						
20-35 years	60	88.2	8	11.8	0.037	1.019-13.795
<20 and >35 years	10	66.7	5	33.3	3.750	
Gestational age						
Normal	56	90.3	6	9.7	0.118	0.887-12.521
Premature/postmature	14	73.7	5	26.3	3.333	
MUAC						1.249-14.648
Normal	55	90.2	6	9.8	0.034	
Chronic energy deficiency	15	68.2	7	31.8	4.278	

Table 3. The impact of causative factors on the occurrence of low birth weight

Variable	Constant (β_0)	Regression Coefficients (β)	p-value	Exp (B)	R^2
Maternal age at pregnancy	5.268	1.298	0.063	3.662	0.169
MUAC	5.268	1.436	0.027	4.203	

Adolescent pregnancy, defined as pregnancy occurring in individuals under the age of 20, presents challenges in meeting the nutritional requirements of both the mother and the developing foetus.(21) The reproductive organs of adolescents, including the pelvis, are often still undergoing growth and development, which can result in a narrower pelvis structure due to incomplete maturation.(22) This immaturity can complicate childbirth. From a psychological perspective, adolescents may not be ready to assume the role of motherhood.(19) Therefore, adolescent pregnancy can have detrimental effects on the well-being of both the mother and child, including premature birth, LBW, and complications during labour, all of which contribute to increased rates of maternal and infant mortality.(23)

Pregnant women aged 35 years and older are also at increased risk of reproductive complications. This phenomenon can be attributed to the negative correlation between advancing age and uterine receptivity, which hinders the successful attachment of the embryo to the endometrial layer.(22) This condition can lead to miscarriage, increase the likelihood of placental detachment, and contribute to ectopic pregnancy. Furthermore, it is worth noting that individuals within this age group may experience reduced placental blood flow, resulting in insufficient oxygen and nutritional supply to the developing baby. According to Detiana (2010), these factors can lead to slower foetal growth rates or lower birth weights.(23)

The bivariate analysis also revealed a significant correlation between the MUAC of pregnant women and the occurrence of LBW in Kemuning Lor Village, as evidenced by a p-value of 0.034 ($p < 0.05$). This finding is consistent with the previous study, where a significant association between MUAC and the occurrence of LBW in newborns was observed, with a p-value of 0.021($p < 0.05$).(24) The multivariate analysis further revealed a significant association between the MUAC of pregnant women and the incidence of LBW in Kemuning Lor Village, Jember Regency.

MUAC is used to assess the likelihood of chronic energy deficiency (CED) in expectant mothers.(25)(26) According to the Indonesian Ministry of Health (2019), a pregnant woman is considered to be in a severe condition if her MUAC measures less than 23.5 cm.(26-28) CED refers to a prolonged state of inadequate intake of calories and proteins, resulting in adverse health outcomes in women of reproductive age and during pregnancy. Failure to address the problem can result in LBW among newborns. This phenomenon occurs due to the increased demands for calories and proteins during pregnancy, which are essential for maternal and foetal growth and development.(29) During the second trimester, there is an increase in calorie requirements to accommodate maternal physiological changes, such as increased blood volume, uterine expansion, breast development, and adipose tissue accumulation. During the third trimester, there is an increased demand for calories to support the growth of the foetus and placenta. Moreover, protein intake is essential for the development of novel placental and foetal tissues, as well as for cell proliferation and differentiation.(30)

The limitation of this study lies in the data sources. The data were obtained from records in the Maternal and Child Health handbook. However, some of the books were incomplete. Therefore, the authors had to select only the complete Maternal and Child Health handbooks to use as data sources for this study. Additionally, this study is limited in its scope, as the discussion of factors causing LBW focuses solely on maternal factors.

CONCLUSION

This study identified several characteristics of pregnant women in Kemuning Lor Village, Jember Regency. Specifically, 27.7% of the participants were found to be anaemic, 3.7% had a tuberculosis risk with a height below 145 cm, 18.1% were pregnant at an age considered to be at risk (either <20 or >35 years), 23.5% had a gestational age falling within the premature/postmature category, 26.5% experienced symptoms of severe early pregnancy sickness, and 15.7% of the mothers gave birth to babies with LBW. A statistically significant relationship was observed between maternal age at pregnancy ($p = 0.037$) and MUAC ($p = 0.034$) in relation to the occurrence of LBW. The odds ratio (OR) analysis revealed that the primary factor influencing LBW in Kemuning Lor Village was found to be maternal MUAC, with an OR of 4.278), followed by maternal age during pregnancy, with an OR of 3.750). No statistically significant correlation was observed between haemoglobin levels ($p = 0.500$), maternal height ($p = 0.408$), maternal gestational age ($p = 0.118$), and the occurrence of LBW. The occurrence of LBW in Kemuning Lor Village was found to be significantly influenced by MUAC, with a p-value of 0.027. This variable accounted for 16.9% ($R^2 = 0.169$) of the variation in LBW cases in the village.

It is crucial to disseminate information regarding pregnancy danger signals and reproductive health to women living in Kemuning Lor Village, Jember Regency. Additionally, efforts are needed to improve the nutritional status of adolescent girls to prepare them for safe pregnancies. These can be achieved by optimizing health services at integrated service posts, focusing on

counselling for prospective mothers, mothers with toddlers, pregnant women, and breastfeeding mothers. The optimisation of counselling activities at integrated service posts can be carried out by providing posters or leaflets containing health information such as pregnancy danger signals, women's reproductive health, and teenage nutrition. With these posters or leaflets, information can be disseminated to families or communities in need. In this digital era, health promotion or counselling can also leverage social media platforms.

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Conflict of Interest

The authors declare no conflict of interest. The founding sponsors had no involvement in the design of this study; data collection, analysis, or interpretation; the writing of the manuscript; and the decision to publish the results.

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