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Maternal Nutritional Status and Hemoglobin Level as Predictors of Low Birth Weight

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ABSTRACT

Low birth weight in infants has a risk of stunting 3 times greater than normal birth weight. The incidence of low birth weight in infants is caused by insufficient nutritional intake received by the fetus. Nutritional status during pregnancy can be seen by examining the mid-upper arm circumference (MUAC), hemoglobin levels, and pre-pregnancy BMI. In 2024, there were 3.6% of babies born with low birth weight at Sukasada 1 Community Health Center. This study aims to determine the relationship between MUAC, Hb levels, and BMI during pregnancy with low birth weight at Sukasada 1 Community Health Center. This study used a cross-sectional design conducted from July to October 2025. The study population was 500 respondents using a correlative sample size formula which resulted in a study sample of 104 respondents. This study used secondary data through the Sukasada 1 Community Health Center register with Fisher's Exact Test. The results showed that the incidence of low birth weight at Sukasada 1 Community Health Center for the period January-July 2025 was 8.7%. This study concluded that there was no significant relationship between mid-upper arm circumference, hemoglobin levels, and BMI with the incidence of low birth weight (LBW).

INTRODUCTION

Pregnancy is a physiological condition closely related to fetal growth and development. During pregnancy, a mother's nutritional needs must be carefully considered. A child's growth and development occur during the first 1,000 days of life, starting from conception until the child is 2 years old [1]. During the first 1,000 days of life, nutritional status during pregnancy requires attention. Nutritional status during pregnancy can be assessed by several factors, such as upper arm circumference, hemoglobin levels, and pre-pregnancy body mass index [2].

Nutritional status that is not adequately met during pregnancy poses a risk of malnutrition in the subsequent cycle, significantly impacting the occurrence of stunting in children. Stunting is a chronic nutritional problem caused by insufficient nutritional intake over a prolonged period. Stunting can be caused by several factors, one of which is the lack of adequate nutrition during pregnancy [3]. Low birth weight in infants has a 3 times greater risk of stunting compared to infants born with normal birth weight [3].

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The World Health Organization (WHO) estimates that 15% to 20% of all births worldwide are low birth weight (LBW), representing more than 20 million per year [4]. 95.6% of these low birth weight cases occur in developing countries. In Indonesia, based on the 2023 SKI analysis, 6.2% of newborns in Indonesia were born with low birth weight (LBW) aged 0-59 months based on documents or memories [5]. In Bali Province, in 2024, it was known that 4.6% of babies were born with low birth weight. Babies with low birth weight contribute to a number of poor health outcomes and are closely related to fetal and neonatal mortality and morbidity, stunted growth and development, and non-communicable diseases.

Lack of nutrition during pregnancy will affect the occurrence of malnutrition in the next cycle so that it can cause LBW in babies [6]. Factors causing pregnant women who suffer from malnutrition or Chronic Energy Deficiency (CED) will affect the growth and development of the fetus so that it can cause LBW [7]. In addition to causing babies with low birth weight, CED in pregnant women can cause babies to experience malnutrition, infant death, disorders in child growth. CED (Chronic Energy Deficiency) can also have an impact on the mother such as prolonged fatigue, tingling, and a pale face.

Pregnant women with chronic energy deficiency will affect the nutritional status of the mother and also become one of the risk factors for anemia in pregnant women. Anemia in pregnancy is a condition where the body has few red blood cells or cells that cannot carry oxygen to various organs of the body [8]. Anemia in pregnancy can be defined as a decrease in Hemoglobin (Hb) levels of less than 11 g / dl during the first and third trimesters or less than 10 g / dl in the second trimester [9]. Decreased Hb levels in pregnant women have the risk of LBW, bleeding before and during childbirth to the death of the mother and baby [10].

The nutritional status of pregnant women is closely related to the baby's birth weight. Maternal nutritional status can also be measured through the mother's body mass index (BMI). BMI is used to determine the mother's required weight gain during pregnancy. According to Scotland et al., 2006 [11] Low body mass index and low weight gain during pregnancy can lead to low birth weight (LBW) babies, while excessive weight gain can lead to the birth of large babies. This is in line with research conducted by Puspita (2019). [12] that there is a significant relationship between pre-pregnancy body mass index and the baby's birth weight.

In 2024, 4.7% of babies born in Buleleng Regency had low birth weight [13]. This is an increase compared to 2023, when data showed 4.04% of babies were low birth weight (LBW). Low birth weight data in Buleleng Regency is distributed across almost all sub-districts, including the Sukasada 1 Community Health Center. Sukasada 1 Community Health Center is one of the community health centers that has births of babies with LBW and experienced an increase in 2024. In 2024 there were 3.6% of babies born with low birth weight [13]. While in 2023 Sukasada 1 Community Health Center there were 2.7% of births with LBW [14]. The birth of babies with LBW in the Sukasada 1 Community Health Center Working Area experienced an increase of 0.9% in 2023 and 2024.

Malnutrition during pregnancy can lead to low birth weight (LBW). Continued malnutrition will negatively impact fetal growth. Nutritional status in pregnant women can be measured by measuring the mid-upper arm circumference. Mothers experiencing chronic energy deficiency tend to tire more easily and feel weak, which can affect the fetus's ability to develop in the womb. Furthermore, CED during labor can lead to difficult and prolonged labor, premature delivery, and postpartum hemorrhage[16]. Based on research conducted by Retnaningtyas et al. (2020)[8], there is a relationship between the occurrence of CED in pregnant women and the occurrence of LBW at Gambir Regional Hospital, Kediri City.

The nutritional status of pregnant women can also be determined by determining their pre-pregnancy BMI. To prepare physically and ensure optimal pregnancy, it is necessary to measure the mother's height and weight to determine her body mass index (BMI)[17]. BMI is also used to determine the recommended maternal weight gain during pregnancy. The recommended weight gain during

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normal pregnancy is 10-12 kg. This weight gain can quickly assess nutritional status and determine whether it is appropriate for gestational age, thus determining the mother's nutritional reserves. A lack of reserves during pregnancy can hinder the delivery of nutrients to the fetus, potentially leading to low birth weight (LBW) in the baby [18].

Efforts have been made to provide information regarding nutritional needs during pregnancy. One government program includes providing information in Maternal and Child Health books on nutrition during pregnancy. Furthermore, ANC examinations are conducted to monitor maternal nutrition during pregnancy, which require mid-upper arm circumference measurements, hemoglobin levels, and weight gain during pregnancy.

Other efforts that have been made to address nutritional issues in Buleleng Regency include the provision of iron supplements to adolescent girls and pregnant women, as well as supplementary feeding to pregnant women with chronic energy deficiency and malnourished toddlers. The provision of PMT aims to meet the nutritional needs of mothers during pregnancy. Of the 71 pregnant women with Special Economic Zones (KE) in the Sukasada 1 Community Health Center work area in 2023, 100% of the mothers received supplementary feeding during pregnancy. However, only 57 (80.3%) of the pregnant women with Special Economic Zones consumed supplementary feeding. In 2024, the coverage of iron supplements consumption by pregnant women in the Sukasada 1 Community Health Center work area was 100%.

Based on the results of a preliminary study conducted by the author from January to July 2025, there were 9 (1.8%) babies born with low birth weight in the Sukasada 1 Community Health Center work area. This indicates that there are still births with LBW in the Sukasada Community Health Center work area. The data also shows that currently there are 48.9% of pregnant women with CED, 89.5% of pregnant women with anemia and 10.4% of pregnant women with an abnormal BMI.

Based on the explanation above, the author has conducted research related to the relationship between upper arm circumference, hemoglobin levels, and body mass index during pregnancy with the incidence of low birth weight at Sukasada 1 Buleleng Health Center.

METHOD

This type of research is a quantitative study with a cross-sectional survey approach. The independent variables used in this study are mid-upper arm circumference, Hb levels, and maternal BMI during the first trimester of pregnancy. The dependent variable in this study is low birth weight (LBW). The MUAC variable is categorized as CED if <23.5 cm. The BMI variable is considered abnormal if <18.5 kg/m². The Hb variable is categorized as anemia if the mother's Hb at the beginning of pregnancy is <11 g/dL. The baby is considered LBW (low birth weight) if its birth weight is <2500 grams. Data collection techniques in this study were carried out by taking secondary data in the form of register data on upper arm circumference, hemoglobin levels and BMI in mothers who gave birth in January-August 2025 and the baby's birth weight. This study was conducted in the working area of Sukasada 1 Community Health Center. The population in this study were all mothers who gave birth registered in the health center register in January-August 2025 as many as 500 people with a sample size of 104 samples that met the inclusion and exclusion criteria and were selected using simple random sampling techniques. Respondents who meet the criteria will then be selected randomly using an application on the computer. Data analysis used was univariate and bivariate analysis. Bivariate analysis with Fisher's Exact Test.

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RESULT AND DISCUSSION

Mothers Characteristics

Table 1. Distribution of mid-upper arm circumference, hemoglobin level, BMI, and birth weight (n=104)

Category	Amount	Percentage (%)
MUAC		
CED	16	15.4
No CED	88	84.6
HB levels		
Anemia	36	34.6
No Anemia	68	65.4
BMI		
Abnormal BMI	43	41.3
Normal BMI	61	58.7
Birth Weight		
Low birth weight	9	8.7
Normal	95	91.3

Based on the results of research on 104 mother respondents in the working area of Sukasada 1 Buleleng Health Center, it is known that most mothers do not experience Chronic Energy Deficiency (CED) as many as 88 people (84.6%), while those who experience CED are 16 people (15.4%). Based on hemoglobin (Hb) levels, the majority of mothers do not experience anemia as many as 68 people (65.4%), while those who experience anemia are 36 people (34.6%). Based on body mass index (BMI), most mothers have a normal BMI as many as 61 people (58.7%), while mothers with abnormal BMI are 43 people (41.3%). As for the birth weight of babies, most babies have a normal birth weight as many as 95 babies (91.3%), while babies with low birth weight (LBW) are 9 babies (8.7%). The results of the study showed that most of the mothers in this study tended to be in good condition during pregnancy and gave birth to babies with normal birth weight.

The results of the study conducted in the working area of Sukasada 1 Health Center showed that the incidence of Chronic Energy Deficiency (CED) during pregnancy of mothers who had given birth was 16 respondents with a percentage of 15.4%. The expected results of this study are to determine the status of Chronic Energy Deficiency (CED) in mothers in the working area of Sukasada 1 Health Center. Chronic Energy Deficiency status can be determined through examination of the upper arm circumference, the results of the examination of the upper arm circumference during pregnancy are considered to have CED if <23.5 cm [5].

Malnutrition during pregnancy can affect the growth of the fetus. Chronic Energy Deficiency (CED) can be caused by an imbalance between energy intake and energy expenditure. According to Fatimah and Yuliani (2019), [19] pregnant women classified as CED are those who experience prolonged energy deficiency, even before pregnancy. The embryo implantation period is a crucial time for ensuring adequate nutritional intake during pregnancy to prevent adverse effects on fetal development in subsequent trimesters.

Hemoglobin levels during pregnancy at Sukasada 1 Community Health Center showed that 36 women experienced anemia during pregnancy, with a prevalence of 34.6%. This data indicates that some pregnant women still experience anemia during pregnancy. *The World Health Organization*

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defines anemia during pregnancy as a condition characterized by hemoglobin (Hb) levels <11 g/dl. This is based on the fact that a decrease in Hb levels below this level is closely associated with an increased risk of obstetric complications such as premature delivery, low birth weight, and postpartum hemorrhage.

The increase in plasma volume is greater than the increase in erythrocyte mass during pregnancy, causing the concentration of hemoglobin and hematocrit to appear to decrease, causing physiological anemia in pregnancy [20]. Anemia examinations during pregnancy are carried out twice, namely in the first trimester and the third trimester. During pregnancy, according to the government program, pregnant women are given 90 iron supplements. Iron supplements or TTD are supplements containing iron that are consumed for the formation of red blood cells or hemoglobin [21]. So that by giving iron supplements, HB levels can increase during pregnancy, which prevents the occurrence of ongoing anemia in pregnancy.

The study found that 41.3% of pregnant women had an abnormal BMI. This demonstrates the importance of assessing maternal nutritional status before pregnancy. BMI measurements are performed early in pregnancy and before conception. BMI measurements during pregnancy will influence recommendations for maternal weight gain during pregnancy, which can be used to assess nutritional needs during pregnancy.

Newborn Babies Characteristics

Table 2. Characteristics of newborn babies (n=104)

Category	Amount	Percentage (%)
Gender		
Female	55	52.9
Male	49	47.1
Birth Weight		
Low birth weight	9	8.7
Normal	95	91.3

Based on results research is known that part big various sex women, namely as many as 55 babies (52.9%), while based on body weight, 91.3% of babies were born with normal birth weight.

Based on the research results, it was found that there were 9 babies (8.7%) born with low birth weight in the Sukasada 1 Community Health Center working area. Low birth weight is a baby's weight of less than 2500 grams. Based on the data, it was found that 6 (10.9%) babies born with LBW were female. This is similar to research conducted by that the majority of LBW respondents were female. These results are also supported by research by Srimiyati et al. (2021) [22] that gender has a significant influence on the incidence of LBW, male gender has a more significant influence. However, this differs from research by Septa, et al. (2011) [23] which shows that infant gender is not a risk factor for LBW.

Low birth weight can be caused by various factors such as maternal age, parity, and pregnancy spacing. Low birth weight can be caused by various factors, primarily related to nutritional status during pregnancy. Research results from Indah & Istri (2020) [24] showed that pregnancy spacing, parity, gestational age, twins, and preeclampsia were significantly associated with the incidence of low birth weight (LBW). These various factors could be risk factors for low birth weight (LBW) at Sukasada 1 Community Health Center.

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Relationship between Upper Arm Circumference During Pregnancy and Low Birth Weight

Table 3. Relationship between upper arm circumference and LBW (n=104)

MUAC	Birth Weight						*P-value*
	Low birth weight		Normal		Amount		
	f	%	f	%	f	%	
Maternal Nutritional Status (CED)	1	6.3	15	93.8	16	100	1.000
No CED	8	9.1	80	90.9	88	100	

Based on the results of the analysis of the relationship between Upper Arm Circumference (MUAC) and birth weight in the Sukasada 1 Community Health Center work area, it is known that of the 16 mothers with CED, there was 1 person (6.3%) who gave birth to a baby with LBW, while of the 88 mothers who did not have CED, there were 8 people (9.1%) who gave birth to a baby with LBW. Based on the results of *the Fisher's Exact Test*, a *p value of 1,000* (p> 0.05) was obtained, which indicates that there is no significant relationship between the status of the Upper Arm Circumference (MUAC) and the incidence of low birth weight (LBW) in the Sukasada 1 Community Health Center work area, Buleleng. Thus, the nutritional status of the mother based on the MUAC does not have a significant effect on the baby's birth weight.

Based on the analysis results, it was found that pregnant women who experienced CED with the incidence of LBW were (6.3%), this result was smaller than mothers who did not experience CED with the incidence of LBW, which was 9.1%. Based on the results of *the Fisher's Exact Test*, a *p value of 1,000* (p> 0.05) was obtained, which indicated that there was no significant relationship between the status of the Upper Arm Circumference (MUAC) and the incidence of low birth weight (LBW) in the Sukasada 1 Health Center work area**.** In line with the research of Khulafaur et al (2015) [25] found that maternal nutritional status (CED) was not associated with low birth weight. This research supported research by Irawati (2020). [26] that there is no relationship between CED and the incidence of low birth weight (LBW), although there is no increase in MUAC during pregnancy, but if there is good fulfillment of macro and micro nutrients, there is the potential for giving birth to a child with a normal birth weight. However, this is in contrast to research conducted by Ogbonna et al. (2007). [27] that upper arm circumference has a greater influence than other variables on the incidence of low birth weight.

Many mothers who experience CED but give birth to babies with normal birth weight because the Sukasada 1 Community Health Center immediately intervened by providing PMT after learning the results of the upper arm circumference measurement of less than 23.5 cm. The PMT program is known to help increase body weight and MUAC [28.] Although providing additional food does not always increase the upper arm circumference, providing nutritious food is very important to meet the macro and micro nutritional needs of pregnant women. Good nutritional fulfillment during pregnancy in pregnant women with CED has a high chance of giving birth to babies with normal birth weight. This is in line with research conducted by Adelfina (2023) [29] that CED mothers who are given additional food during pregnancy have the opportunity to give birth to babies with normal birth weight.

The Relationship Between Hemoglobin Levels During Pregnancy and Low Birth Weight

Table 4. The relationship between hemoglobin levels during pregnancy and LBW (n=104)

HB	Birth Weight						*P-value*
	Low birth weight		Normal		Amount		
	f	%	f	%	f	%	
Anemia	4	11.1	32	88.9	36	100	0,716
No Anemia	5	7.4	63	92.6	68	100	

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Based on the results of the analysis of the relationship between hemoglobin (Hb) levels and birth weight in the Sukasada 1 Community Health Center work area, it is known that of the 36 mothers who experienced anemia, there were 4 people (11.1%) who gave birth to babies with LBW, while of the 68 mothers who were not anemic, there were 5 people (7.4%) who gave birth to babies with LBW. Based on the results of *the Fisher's Exact Test*, the *p value was obtained = 0.716* (p> 0.05), so it can be concluded that there is no significant relationship between hemoglobin levels during pregnancy and the incidence of low birth weight (LBW) in the Sukasada 1 Community Health Center work area, Buleleng.

The results of the analysis of the relationship between hemoglobin (Hb) levels and birth weight in the Sukasada 1 Community Health Center work area, it was found that of the 36 mothers who experienced anemia in the first trimester, there were 4 people (11.1%) who gave birth to babies with LBW, while of the 68 mothers who were not anemic, there were 5 people (7.4%) who gave birth to babies with LBW. Based on the results of *the Fisher's Exact Test*, a *p value of 0.716* (p> 0.05) was obtained, so it can be concluded that there is no significant relationship between hemoglobin levels during pregnancy and the incidence of low birth weight (LBW) in the Sukasada 1 Community Health Center work area, Buleleng. This is in line with research conducted in Rural Bangladesh that there is no significant relationship between anemia and the incidence of low birth weight. [30] Also in line with the research of MI Maulana et al (2022) [31] that there is no relationship between anemia and the incidence of LBW at Lhok Seumawe City Hospital in 2020. This result differs from the results of research conducted by Lestari (2021) [32] that there is a significant relationship between anemia and the incidence of LBW

This research is also supported by research Irawati (2020) [26] found no relationship between anemia in pregnant women and the incidence of low birth weight (LBW) due to the provision of 90 iron tablets to pregnant women. This condition occurred at the research location where, after the mother underwent laboratory tests early in her pregnancy and the Hb value was <11 g/dl, the officer provided immediate intervention by providing nutritional counseling and also administering iron tablets throughout the pregnancy. This is in line with research by Zulaidah et al. (2014). [33] supplementary feeding in the control group had a significant relationship in increasing the birth weight of babies.

Anemia in pregnancy can be caused by various factors such as maternal age, gestational age, spacing of children, and maternal nutritional status. This is in line with research conducted by Wahyuningsih et al. (2023) [34] that gestational age and maternal occupation have a strong interaction with the incidence of anemia during pregnancy. Based on research conducted by MS Maulanac (2020), [35] that there is a significant relationship between the incidence of anemia and the mother's gravid status, mothers with multigravida status have a greater risk of experiencing anemia.

Relationship between Body Mass Index in Pregnancy and Low Birth Weight

Table 5. Relationship between BMI in pregnancy and LBW (n=104)

BMI	Birth Weight						*p*
	Low birth weight		Normal		Amount		
	f	%	f	%	f	%	
Abnormal	6	14.0	37	86.0	43	100	0.157
Normal	3	4.9	58	95.1	61	100	

Based on the results of the analysis of the relationship between the Body Mass Index (BMI) of pregnant women and the weight of babies born in the working area of Sukasada 1 Health Center, it is known that of the 43 mothers with abnormal BMI, there were 6 people (14.0%) who gave birth to babies with LBW, while of the 61 mothers with normal BMI, there were 3 people (4.9%) who gave birth to

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babies with LBW. Based on the results of *the Fisher's Exact Test*, the *p value = 0.157* (p> 0.05) was obtained, which means there is no significant relationship between the BMI status of pregnant women and the incidence of low birth weight (LBW) in the working area of Sukasada 1 Health Center Buleleng.

Based on the results of the analysis of the relationship between the Body Mass Index (BMI) of pregnant women and the weight of babies born in the working area of Sukasada 1 Health Center, it is known that of the 43 mothers with abnormal BMI, there were 6 people (14.0%) who gave birth to babies with LBW, while of the 61 mothers with normal BMI, there were 3 people (4.9%) who gave birth to babies with LBW. Based on the results of *the Fisher's Exact Test*, the *p value = 0.157* (p> 0.05) was obtained, which means there is no significant relationship between the BMI status of pregnant women and the incidence of low birth weight (LBW) in the working area of Sukasada 1 Health Center Buleleng. This study is in line with the research of Weku et al (2016)[36] found no significant relationship between early pregnancy BMI and neonatal outcomes, namely birth weight, infant mortality, and APGAR score. This differs from the research conducted by Ogbonna et al. (2007)[27] that body mass index has a significant relationship with the baby's birth weight.

Pre-pregnancy BMI is used as a guideline for weight gain recommendations during pregnancy. Maternal weight gain during pregnancy is considered to indicate adequate nutritional intake during pregnancy, organ function, and fetal growth and development. The occurrence of babies with normal birth weights born to mothers with abnormal BMIs is likely due to weight gain during pregnancy in accordance with weight gain recommendations, so that nutritional needs during pregnancy are met properly. According to Kurniati et al. (2022)[2] these events can occur because the mother is able to balance her pregnancy with normal weight gain and adequately meet nutritional needs, ensuring the fetus receives sufficient nutrients for growth and avoids complications. This is supported by research. Oktadianingsih et al (2017)[37] that there is a significant influence between weight gain during pregnancy and birth weight.

CONCLUSION

The results of the study showed that most mothers had normal mid-upper arm circumference (MUAC), the majority of mothers did not experience anemia with a body mass index (BMI), most mothers had a normal BMI. There was no significant relationship between mid-upper arm circumference, hemoglobin levels and body mass index during pregnancy and the incidence of low birth weight (LBW). The findings of this study indicate that there are still pregnant women who have poor nutritional status during pregnancy, the involvement of various parties is needed to ensure proper nutritional fulfillment during pregnancy. This study is expected to provide an overview of the importance of nutrition or conditions during pregnancy with the incidence of LBW. Service providers are expected to maintain and improve intervention efforts for mothers with nutritional status problems during pregnancy. It is hoped that mothers can better maintain and prepare nutrition from before pregnancy and during pregnancy. Other researchers are expected to conduct research with a case-control study design to minimize other factors that can cause the birth of low birth weight babies.

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