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The Relationship Between Hemoglobin Levels of Pregnant Mothers and Low Birth Weight at Dr. Moewardi Regional Hospital Surakarta

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ABSTRACT

Background: Anemia is one of the nutritional problems commonly encountered in pregnant women. The World Health Organization (WHO) states that approximately 37% of pregnant women worldwide experience anemia. This condition reduces the amount of oxygen and nutrient supply available in the mother's blood, which can disrupt the development and growth of the fetus. The growth disturbances in the fetus can be evaluated through anthropometric examinations, such as measuring the birth weight of the baby. This study aims to determine the relationship between hemoglobin levels in pregnant women and the incidence of low birth weight.
Subjects and Method: A cross-sectional study was conducted at Dr. Moewardi Regional Hospital in Surakarta from May to July 2024. A total of 68 pragnant women selected for this study. The dependent variable was newborn baby weight. The independent variable was hemoglobin levels of pregnant women in the third trimester. The data obtained from patient medical records. The data analyzed using a multiple logistic regression.
Results: Low Hb levels (anemia) increase the incidence of LBW. Pregnant women with low Hb levels (anemia) have a 2.30 times greater risk of experiencing LBW compared to pregnant women with normal HB levels, but this result was not statistically significant (OR= 2.30; 95% CI = 0.14 to 38.63; p = 0.563).
Conclusion: Low Hb levels increase the incidence of LBW, but it is not statistically.

Keywords: anemia, hemoglobin, anthropometry, birth weight.

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BACKGROUND

Pregnancy is a physiological process that results in changes in a woman's body systems to support the growth and development of the fetus. Throughout pregnancy, it is important to maintain the health and well-being of pregnant women through adequate nutritional intake so that the fetus can grow healthily and optimally. One way to determine whether nutritional intake is sufficient

is through laboratory and anthropometric examinations.

Anemia is one of the most common health problems faced by pregnant women (Ernawati, 2017). Anemia during pregnancy is a condition where hemoglobin (Hb) levels in pregnant women are <11 g/dL during the first and third trimesters, while during the second trimester, Hb levels are <10.5 g/dL (Putri, Habibah, and Swastini, 2022). Based on several studies, there are two factors that influence anemia in pregnant women: direct and indirect factors. Direct factors include aspects that directly affect Hb levels in pregnant women, such as iron tablet consumption, nutritional status, and infections. Meanwhile, indirect factors involve aspects such as parity, maternal age, spacing between pregnancies, socioeconomic status, education, and cultural factors (Minasi et al., 2021).

The World Health Organization (WHO) states that approximately 37% of pregnant women worldwide experience anemia. According to the 2018 Riskesdas report, the number of pregnant women suffering from anemia in Indonesia reached 48.9% (Riskesdas Ministry of Health of the Republic of Indonesia, 2018). In Central Java Province alone, the number of pregnant women suffering from anemia is 27.61% (Central Java Provincial Government, 2020).

During pregnancy, anemia can have negative effects on the health of both mother and child. Some negative effects on mothers include fatigue, poor work capacity, immune system disturbances, increased risk of heart disease, and higher mortality rates (Stephen et al., 2018). Additionally, anemia during pregnancy is significantly associated with the risk of low birth weight (LBW) (Wulandari et al., 2021). This is due to a decrease in oxygen and nutrient supply in the mother's blood, leading to disruptions in fetal development and growth (Mulianisaa, Tunggal, and Suhrawardi, 2021).

Infants classified as LBW are born weighing less than 2500 grams. In 2022, approximately 82.0% of newborns had their weights measured across a total of 34 provinces. From this weighing data, it was found that there were 3.3% of infants with LBW conditions (Ministry of Health of the Republic of Indonesia, 2023). LBW can not only lead to neonatal death but also increase the risk of stunting, diabetes, hypertension, and heart disease.

Based on the above description, it is evident that monitoring hemoglobin levels during pregnancy is crucial. One way to determine if someone has anemia is by measuring their blood Hb levels since Hb functions to transport oxygen (O^2) to all body tissues.

SUBJECTS AND METHOD

1. Study Design

This study employs a scoping review methodology following the framework proposed by Arksey and O'Malley, which allows for the exploration and mapping of literature related to the relationship between Acute Respiratory Infections (ARIs) and stunting in toddlers.

2. Population and Sample

The population of this study consists of all infants born at Dr. Moewardi Regional Hospital in Surakarta during the period from January 2022 to June 2024. The sample for this study was obtained through purposive sampling, where the researcher selected samples based on inclusion and exclusion criteria. The sample size determination for this study used a cross-sectional formula, resulting in a minimum sample size of 67. The researcher collected a total of 68 data points for the study.

3. Study Variables

The independent variable in this study is the hemoglobin (Hb) level of pregnant women in the third trimester. The dependent variable in this study is the birth weight of newborns.

4. Operational Definition of Variables

Hemoglobin (Hb) is a protein molecule found only in erythrocytes and plays a crucial role in transporting oxygen (Sherwood, 2018). The classification of hemoglobin levels in pregnant women is divided into four categories: no anemia (Hb ≥ 11.0 g/dL); mild anemia (Hb 10.0-10.9 g/dL); moderate anemia (Hb 7.0-9.9 g/dL); and severe anemia (Hb < 7.0 g/dL). Birth weight is defined as the measurement of an infant's weight within one hour after birth. According to Ro (2019), newborn birth weight is classified into three categories: low birth weight < 2500 grams; normal birth weight 2500 – 4000 grams; and high birth weight > 4000 grams.

5. Study Instruments

All data obtained were sourced from patient medical records.

6. Data analysis

The data obtained will be analyzed using Logistic Regression test to examine the relationship between hemoglobin levels in pregnant women and the incidence of low LBW at Dr. Moewardi Regional Hospital in Surakarta. The application used for this data analysis is SPSS Statistics version 29.0.2.0 from the year 2023.

7. Research Ethics

Ethical issues in research, including informed consent, anonymity, and confidentiality, were carefully managed throughout the study. The ethical clearance letter was issued by the Research Ethics Committee at Dr. Moewardi Hospital, Surakarta, Indonesia, with reference number 1.430/V/HREC/-2024, on May 29, 2024.

RESULTS

1. Sample Characteristics

According to (Table 1), there are 68 mothers aged between 25 and 35 years. There are two categories based on the type of delivery: spontaneous, with 51 individuals (75%), and cesarean section (CS), with 17 individuals (25%). The hemoglobin levels of pregnant women are classified into four categories: no anemia, with 47 individuals (69.1%); mild anemia, with 13 individuals (19.1%); moderate anemia, with 7 individuals (10.3%); and severe anemia, with 1 individual (1.5%).For the gender category of the infants, there are two classifications: male infants, totaling 32 (47.1%), and female infants, totaling 36 (52.9%). Newborns are categorized into three groups based on their birth weight: LBW, with 2 infants (2.9%); normal birth weight, with 66 infants (97.1%); and high birth weight, with 0 infants (0%).

Referring to (Table 2), the mean hemoglobin level of pregnant women is 11.48 g/dL, with a minimum value of 4.2 g/dL and a maximum value of 14.8 g/dL. Additionally, the average birth weight of newborns is 3059.39 grams, with a minimum value of 2100 grams and a maximum value of 4000 grams.

2. Bivariate Analysis

Table 3 show that low Hb levels (anemia) increase the incidence of LBW. Pregnant women with low Hb levels (anemia) have a 2.30 times greater risk of experiencing LBW compared to pregnant women with normal HB levels, but this result is not statistically significant (OR = 2.30; 95% CI = 0.14 to 38.63; p = 0.563).

Table 1. Distribution of research sample characteristics

Characteristics	Frequency	Percentage (%)
Mother's Age (year)		
20-25	23	33.8
26-30	21	30.9
31-35	24	35.3
Type of Delivery		
Spontaneous	51	75
Cesarean Section (CS)	17	25
Hemoglobin Level (g/dL)		
No Anemia	47	69.1
Anemia	21	30.9
Infant Gender		
Male	32	47.1
Female	36	52.9
Newborn Birth Weight		
Low Birth Weight (LBW)	2	2.9
Normal Birth Weight	66	97.1

Table 2. Research sample characteristics data based on maternal hemoglobin levels and newborn birth weight

Characteristic	Mean	SD	Min	Max
Maternal Hemoglobin Level (g/dL)	11.48	1.54	4.2	14.8
Newborn Birth Weight (g)	3059.39	362.70	2100	4000

Table 3. Logistic regression about maternal hemoglobin levels and newborn birth weight

Variable	OR	95% CI		p
		Lower limit	Upper limit	
Maternal Hemoglobin Level (g/dL)	2.30	0.137	38.628	0.563

DISCUSSION

This study was conducted at Dr. Moewardi Regional Hospital in Surakarta from May 2024 to July 2024 using medical record data. According to the research findings, there is no significant relationship between hemoglobin levels in pregnant women and the incidence of low birth weight (LBW). This study show that low Hb levels (anemia) increase the incidence of LBW. Pregnant women with low Hb levels (anemia) have a 2.30 times greater risk of experiencing LBW compared to pregnant women with normal HB levels, but this result is not statistically significant (OR = 2.30; 95% CI = 0.14 to 38.63; p = 0.563).

Based on the study by Tampubolon et al. (2023), a similar conclusion was reached, showing no significant relationship between hemoglobin levels in pregnant women and LBW. This was evidenced by a Chi-Square calculation yielding a p-value of 0.394 (p > 0.05). Research conducted by Nuryani and Handayani (2022) also reported a p-value of 0.703, indicating no relationship between hemoglobin levels in pregnant women and birth weight.

In contrast, a study by Lusi et al. (2019) yielded different results. Their research found a p-value of 0.05 ($p \leq 0.05$), suggesting a relationship between hemoglobin levels in pregnant women and LBW. Similarly, Marini et al. (2023) stated that there is a relationship between hemoglobin levels in pregnant women and LBW at Pambalah Batung Regional Hospital, with a p-value of 0.004 confirming this.

The varied results from these studies may be influenced by several factors, including differences in sample size and characteristics, the location of the sample population, the types of tests used, and the classification of research variables. In this study, the total sample collected was only 68, consisting of 47 non-anemic pregnant women and 21 anemic pregnant women. This indicates that the number of anemic pregnant women is fewer than that of non-anemic pregnant women.

Additionally, this study only identified 2 infants with LBW and no infants with normal birth weight. The limited sample size in this research could be attributed to restrictions based on gestational age. The gestational age chosen for this study was full-term pregnancy (37-42 weeks), aiming to focus the research on the effect of hemoglobin levels on LBW incidence. Biologically, an infant's weight will increase as gestational age increases. If the gestational age is less than optimal, the development and growth of the infant's organs may not be complete, potentially affecting birth weight (Silaban et al., 2024).

This is supported by research from Pitriani et al. (2023), which concluded that there is a relationship between gestational age and LBW at Drs. H. Abu Hanifah Regional Hospital in 2022 ($p = 0.005$). Another study by Tarigan et al. (2023) found that the most influential confounding variable was gestational age with an Odds Ratio of 2.71.

The characteristics of the sample in this study are pregnant women aged 20-35 years. Other characteristics, such as socioeconomic status, health history, and lifestyle habits, were not examined in this research. The population for this study consists of pregnant women and the infants born at Dr. Moewardi Regional Hospital in Surakarta.

Current theory does not align with the results of this study. According to theory, low birth weight in infants can be caused by low hemoglobin levels in pregnant women due to a lack of nutrition and oxygen from the placenta. Infant birth weight is influenced by decreased Hb levels as gestation progresses, which can lead to maternal anemia and hypoxia risks. Reduced blood flow to the uterus can cause asphyxia and decreased growth, resulting in low birth weight. Therefore, additional iron is needed during pregnancy to increase red blood cell counts and support healthy placenta growth and fetal red blood cells. Pregnant women who regularly consume iron have a lower risk of decreased hemoglobin levels (Setyawati and Arifin, 2022).

The study by Xiong et al. (2023) identified 4 pregnant women with hemoglobin concentrations above 14 g/dL, who had a 50 risk of low birth weight (LBW). High hemoglobin concentrations can lead to LBW for three reasons. First, elevated Hb levels have been predicted to cause suboptimal supply of oxygen and nutrients to the placenta and fetus, increasing blood viscosity and leading to inadequate plasma volume expansion. Second, excessive iron intake can induce oxidative stress through postprandial increases in unbound iron in circulation, which may result in lipid peroxidation and damage to placental DNA. Third, there is also the potential for excess

iron to alter the maternal gut microbiome and increase the risk of copper and zinc deficiencies, which can impact birth outcomes. However, with only 4 participants having hemoglobin concentrations above 14 g/dL, the sample size is too small to achieve statistical efficiency.

The findings of this study align with those of Khairunnisa, Wiyati, and Adespon (2019), which reported a p-value of 1.000, indicating no significant relationship between anemia and LBW. Additionally, research conducted by Fajriana and Buanasita (2018) also concluded that there is no meaningful relationship between anemia and LBW (p = 0.006).

Several factors may explain the discrepancy between these findings and existing theories. In this study, only one pregnant woman was found with severe anemia, two infants had low birth weight, and no infants were found with high birth weight. This limitation may restrict the use of appropriate statistical analysis methods, potentially affecting the reliability of the results obtained. Given these numbers, this study cannot employ the Chi-Square test due to contingency tables having expected frequencies of less than 5. Therefore, an alternative statistical test is necessary: Fisher's Exact test and category merging for research variables. This selection is due to the expected frequency being less than 5 and the research variables being categorical data. Merging categories is also essential because one requirement for Fisher's Exact test is that the contingency table must be 2x2.

Another factor to consider is confounding factors. In this study, these confounding factors could not be controlled, which may influence the results of the statistical analyses performed. Nutritional status, parity count, maternal age, pregnancy spacing, and education status are all factors that raise doubts in this research.

The well-being, growth, and development of the fetus in utero are significantly influenced by the nutritional status of pregnant women. The fetus receives nutrients for its growth and development from the food consumed by the mother. This intake plays a role in determining the calories and micronutrients entering the mother's body, providing energy as well as supporting cell repair and regeneration. If a pregnant woman does not have enough energy, her body cannot increase blood volume or balance hormonal changes necessary for fetal growth and development. In other words, poor nutritional status in pregnant women will result in babies with LBW (Hamalding, Oka, and Ika, 2023). According to Puspitaningrum (2018), a p-value of 0.016 indicates a relationship between maternal nutritional status and LBW incidence.

A high parity count can lead to vascular dysfunction in the uterus. Repeated pregnancies also reduce uterine tissue elasticity due to repeated stretching from previous pregnancies. This increases the risk of fetal position abnormalities as well as issues with placental and fetal growth. Damage to uterine blood vessel walls can occur from repeated pregnancies, thereby hindering nutrient supply to the fetus during subsequent pregnancies, which can result in LBW births. Research conducted by Martinus et al. (2023) found a significant relationship between parity count and LBW, evidenced by a p-value of <0.001

Pregnancy at an age below 20 years is considered high-risk because the mother is still in a growth phase, leading to nutritional competition between the fetus and the mother. Consequently, the nutritional intake for the fetus may be compromised. Additionally, the mother's pelvis may not be fully developed, and the maturity of the eggs may not be optimal, which can result in low birth weight babies. Conversely, pregnancies

at age 35 and older are also high-risk due to degenerative changes in the reproductive system and hormonal imbalances (Marini et al., 2023). According to a study by Pitriani et al. (2023), there is a relationship where pregnant women of risky ages are potentially 2.671 times more likely to experience low birth weight.

Furthermore, mothers with a parity interval of less than 2 years are at risk of having LBW infants because their reproductive organs have not fully recovered. Additionally, the mother's nutritional intake may not be sufficient to support a new pregnancy, and shorter breastfeeding duration can affect recovery. This situation can increase the risk of delivering LBW babies and raise the likelihood of bleeding during childbirth. Recovery needed involves not only physical recovery but also emotional recovery (Pitriani et al., 2023). Based on research findings, a significant relationship was found between pregnancy spacing and LBW, evidenced by a p-value of 0.000 (Martinus et al., 2023).

Educational status can influence pregnant women's attitudes toward managing nutritional intake and choosing healthcare services during pregnancy. Mothers with lower educational levels tend to have limited thinking and decision-making abilities, which can negatively impact prenatal care and access to important information regarding necessary nutritional intake. Better knowledge about maternal and child health is associated with higher educational status, which can motivate individuals to engage in better healthcare practices and undergo regular prenatal check-ups (Pertiwi et al., 2022). This condition aligns with research findings stating that mothers with low educational status have a 1.33 times higher risk of giving birth to LBW infants compared to those with higher educational status (Yuwana et al., 2022).

In addition, other factors that can influence research variables include the use of supplements related to anemia and exposure to cigarette smoke. According to research by Devi et al. (2023), iron tablet supplementation can increase hemoglobin levels in pregnant women. The iron content in iron tablets is about 60 mg, equivalent to 200 mg of ferrous sulfate. Ferro is a form of iron that is more easily absorbed by the body; therefore, oral iron tablets come in various formulations containing different iron salts such as ferrous sulfate, ferrous gluconate, and ferrous fumarate. One micronutrient responsible for hemoglobin formation is iron.

Moreover, exposure to cigarette smoke can reduce hemoglobin levels in pregnant women due to chemicals present in cigarette smoke, particularly carbon monoxide (CO). Carbon monoxide binds reversibly to hemoglobin forming carboxyhemoglobin, which is more stable than oxyhemoglobin. This impairs hemoglobin's ability to carry oxygen, thereby decreasing oxygen supply to tissues. Additionally, free radicals and tar from cigarette smoke can cause damage to bone marrow leading to hemolysis of red blood cells. Research shows a p-value of 0.000 indicating a significant relationship between exposure to cigarette smoke and anemia incidence (Martini et al., 2023).

Several limitations of this study should be considered. First, the only way to determine hemoglobin levels in pregnant women and birth weight was through secondary data from medical records without direct measurement or analysis of hemoglobin levels during each trimester of pregnancy. Furthermore, the study did not have sufficient time or available tools to examine factors such as nutritional status, parity count, maternal age, pregnancy spacing, and educational status. Lastly, since the sample used was drawn from only

one population area, the results cannot be generalized for comparison with populations elsewhere.

AUTHOR CONTRIBUTION

Otniel Liandoro and Aisya Fikritama for designing the study, collecting data, analyzing data, and drafting the discussion of this research. Meanwhile, Pitra Sekarhandini, and Pridania Vidya provided valuable advice and guidance to enhance the quality of the research.

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CONFLICT OF INTEREST

There are no conflicts of interest.

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