International Journal Of Health, Engineering And Technology (IJHET) *E-ISSN 2829 - 8683*
Volume 5, Number 4, November 2026, *Page. 3894 - 3902*
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The Relationship Between Body Mass Index-Based Obesity And Hemoglobin Levels Among Women Of Reproductive Age Aged 20–29 Years

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Abstract

Anemia is a condition of lack of hemoglobin in the blood that can have a negative impact on health, especially in women of childbearing age (WUS) in the age range of 20-29 years. On the other hand, obesity is also a global health problem that can affect hemoglobin levels through chronic inflammation. Although some studies have shown a link between body mass index (BMI) and hemoglobin levels, the results still vary. This study aims to evaluate the relationship between obesity based on BMI and hemoglobin levels in WUS aged 20-29 years in Medan City. The type of study was descriptive analytical with a cross-sectional research design. The sample used in this study was Women of Childbearing Age (WUS) in the age range of 20-29 years who were obese in Medan Deli District with a total of 72 respoden. This study was carried out by measuring weight, height and hemoglobin respoden levels. The measurement results were analyzed by univariate and bivariate tests using the chi square test. The majority of women of childbearing age in the age range of 20-29 years were found to be in the category of Level I Obesity, Low Hemoglobin Levels, and the difference between Grade II Obesity and Low Hemoglobin Levels with P Value = 0.003 at a 95% confidence level and an odds ratio (OR) value of < 0.202. There is a significant relationship between Level II Obesity and low Hemoglobin Levels.

Keywords: Hemoglobin, Obesity, Women of Childbearing Age.

INTRODUCTION

Hemoglobin (Hb) is a protein molecule in erythrocytes that serves as the primary transporter of oxygen from the pulmonary alveoli to peripheral tissues and carries carbon dioxide back to the lungs. Hemoglobin plays a vital role in ensuring adequate oxygenation of the body's cells and organs. Normal hemoglobin levels range from 13–18 g/dL in men and 12–16 g/dL in women. Hemoglobin levels below the normal range indicate anemia, which can cause various symptoms, including fatigue, weakness, and reduced cognitive function.

Women of reproductive age are particularly susceptible to anemia because they naturally experience menstruation, pregnancy, and childbirth throughout their reproductive life. Women of reproductive age (WRA) are defined as women aged 15–49 years, with peak reproductive years occurring between 20 and 29 years. According to the 2021 statistical report of the National Population and Family Planning Board (BKKBN), North Sumatra Province had the second-highest population of women of reproductive age in Indonesia, totaling 1,303,373 individuals within the reproductive age range. In Medan City, there were 186,904 women of reproductive age, making it the district with the highest number in the province. The Medan City Population and Civil Registration Office reported that, in 2022, Medan Deli District had the largest population of women aged 20–29 years, totaling 16,045 individuals.

According to a 2018 report by the World Health Organization (WHO), the prevalence of anemia among women of reproductive age reached 29.6%. WHO also reported that Southeast Asia had the highest prevalence of anemia among women of reproductive age, at 46.3%. The 2018 Basic Health Research (Riskesdas) reported that the prevalence of anemia in Indonesia reached 48.9%, while the prevalence among adolescents aged 15–24 years was 32%. In North Sumatra Province, the prevalence of anemia was 54.5% in 2016 and increased to 58.2% in 2017. In Medan City, the prevalence of anemia was recorded at 26.5% in 2017.

Anemia among women of reproductive age can have lasting consequences during pregnancy, potentially compromising maternal health and fetal development.

Obesity has also become an increasingly prevalent global health problem, including among women of reproductive age. According to the 2013 Basic Health Research (Riskesdas), the prevalence of obesity among women of reproductive age in Indonesia was 32.9%. By 2018, the prevalence of overweight and obesity among women of reproductive age in Indonesia had increased to 44.4%. According to Riskesdas 2018, women aged 20–29 years were more likely to experience obesity than men, with prevalence rates of 39.8% and 22.7%, respectively. Similar findings were reported in North Sumatra, where the prevalence of obesity was 32.8% among women of reproductive age and 18.7% among men. These findings indicate that women have a higher risk of obesity than men.

Obesity is often associated with chronic inflammation in the body, which can adversely affect red blood cell production and distribution, as well as hemoglobin levels. This chronic inflammation can disrupt the normal functioning of the bone marrow, an organ essential for red blood cell production. Consequently, hemoglobin levels may decrease, potentially leading to health problems caused by inadequate tissue oxygenation. Persistent inflammation can impair hematopoiesis, thereby reducing the efficiency of oxygen transport by the blood. These mechanisms suggest that poorer nutritional status may be associated with lower hemoglobin levels. However, if the body can overcome disruptions in iron absorption caused by obesity-related chronic inflammation, hemoglobin levels may remain within the normal range.

Obesity is also associated with various comorbidities, including hypertension, hyperlipidemia, type 2 diabetes, and coronary heart disease. Individuals with a body mass index (BMI) in the obese category are more likely to experience these conditions than those with a normal BMI.

Muhammad Nur Hasan Syah (2022, Jakarta) reported an association between body mass index and hemoglobin levels among adolescent girls. Amalia Nafisa et al. (2023, Yogyakarta) also reported an association between BMI and hemoglobin levels among obese adolescent girls. Nutritional status is an important factor influencing hemoglobin levels in the body. Inadequate nutrient intake, particularly iron, increases the risk of anemia or hemoglobin deficiency. Such nutritional deficiencies can impair adequate hemoglobin production, resulting in anemia.

However, several studies have reported no association between BMI and hemoglobin levels. Putri Engla Pasalina et al. (2019, Padang) found no association between BMI and hemoglobin levels among women of reproductive age. Dwi Eni Danarsih et al. (2023, Yogyakarta) similarly reported no association between BMI and hemoglobin levels among adolescent girls. Putu Uci Paramudita et al. (2020, Denpasar) also found no association between BMI and hemoglobin levels or the severity of anemia among adolescent girls. These findings may be explained by the fact that anemia is not determined solely by BMI but is more strongly influenced by the adequacy of essential macronutrients and micronutrients, such as lipids, iron, and vitamin C, which play direct roles in hematopoiesis. Individuals with either low or high BMI do not necessarily consume adequate amounts of iron and other micronutrients. Therefore, overall nutritional intake plays an important role in anemia risk, regardless of BMI status.

The varying findings reported in previous studies regarding the relationship between obesity and hemoglobin levels among women of reproductive age highlight the need for further investigation. This study aims to provide a clearer understanding of whether an association exists between obesity, as determined by body mass index, and hemoglobin levels among women of reproductive age aged 20–29 years.

RESEARCH METHODS

Research Design

This study employed an analytical descriptive method with a cross-sectional research design.

Research Time and Location

Research Period

Table 1. Research Schedule

Type of Activity	July	August	September	October	November	December
Sample Preparation	■					
Research Implementation		■	■			
Data Collection		■	■			
Data Organization				■		
Data Analysis					■	
Report Preparation						■

Source: Researcher, 2024

Research Location

This study was conducted in Medan Deli District, Medan City, North Sumatra Province, Indonesia.

Research Population and Sample

The population in this study consisted of women of reproductive age (WRA) aged 20–29 years residing in Medan Deli District, Medan City, North Sumatra Province, Indonesia.

The sample consisted of obese women of reproductive age (WRA) aged 20–29 years residing in Medan Deli District, Medan City, North Sumatra Province, who met the inclusion and exclusion criteria.

Purposive sampling is a non-probability sampling method in which participants are selected based on specific criteria or characteristics relevant to the research objectives. This method aims to obtain comprehensive, in-depth, and focused data to support more accurate and valid analyses. In this study, participants were selected based on the following characteristics: women of reproductive age aged 20–29 years who were classified as obese and resided in Medan Deli District, Medan City, North Sumatra Province, Indonesia.

Sample Size

The sample size for this cross-sectional study was determined using the Lemeshow formula, as follows:

$$n = \frac{z^2 \times P\,(1-P)}{d^2}$$

Description:
n : Sample
Z^2 : Z-score at 90% confidence level = 1.64
P : Maximum estimate 50% = 0.5
D : Margin of error 10% = 0.1

$$n = \frac{z^2 \times P\,(1-P)}{d^2}$$

$$n = \frac{1{,}64^2 \times 0{,}5\,(1-0{,}5)}{0{,}1^2}$$

$$n = \frac{2{,}68 \times 0{,}25}{0{,}01}$$

$$n = \frac{0{,}67}{0{,}01}$$

$$n = 67$$

The total sample size used in this study was 67 participants.

Inclusion Criteria

1. Women of reproductive age without disabilities or physical impairments.
2. Women with no history of chronic diseases, including heart disease, hypertension, and diabetes mellitus.
3. Women who were not pregnant and were not under medical supervision.
4. Women who voluntarily agreed to participate in the study.
5. Women of reproductive age who were classified as obese.

Exclusion Criteria

1. Women whose body weight and height were difficult to measure.
2. Women whose hemoglobin levels were difficult to measure.
3. Women who were currently following a special dietary program.

Data Collection Techniques

Data Collection Instruments

Data collection instruments are tools or methods used to gather information or data from research participants. The instruments used in this study included a respondent identification questionnaire covering name, age, ethnicity, highest level of education, marital status, occupation, medical history, menstrual history, history of iron supplementation, and dietary history.

The instruments used to assess obesity included a weighing scale, a microtoise (stadiometer), and an anthropometric reference guide. Hemoglobin levels were measured using a Family Dr Hb meter.

Data Sources

Primary data were obtained directly from the research participants. Data collection involved direct measurements of body weight and height, followed by the calculation of body mass index (BMI). Subsequently, the participants' hemoglobin levels were measured using an Hb meter.

RESULTS AND DISCUSSION

Research Results

This study received ethical approval from the Health Research Ethics Committee (KEPK) of the Faculty of Medicine, Universitas Muhammadiyah Sumatera Utara, under approval number 1290/KEPK/FKUMSU/2024.

The study was conducted by measuring body weight, height, and hemoglobin levels among women of reproductive age (WRA) aged 20–29 years in Medan Deli District, Medan City, North Sumatra Province, Indonesia. A total of 72 respondents participated in this study. Primary data were obtained directly from the research participants. The collected data were subsequently analyzed and processed using SPSS software. The research findings are presented and discussed in the following sections.

Univariate Analysis

Frequency Distribution of Age, Body Mass Index, and Hemoglobin Levels

Table 1. Frequency Distribution of Age, Body Mass Index, and Hemoglobin Levels

Variable	Frequency (n)	Percentage (%)	Mean/Mode
Age			25.19
20–23 years	19	26.4	
24–26 years	24	33.3	
27–29 years	29	40.3	
Body Mass Index (BMI)			25.71
Class I Obesity	41	56.9	
Class II Obesity	31	43.1	
Hemoglobin Levels			

Low Hemoglobin	31	43.1	
Normal Hemoglobin	41	56.9	

Based on age distribution, among women of reproductive age with obesity aged 20–29 years, 19 respondents (26.4%) were aged 20–23 years, 24 respondents (33.3%) were aged 24–26 years, and 29 respondents (40.3%) were aged 27–29 years. The mean age was 25.19 years.

Regarding BMI, 41 respondents (56.9%) were classified as having Class I obesity, while 31 respondents (43.1%) had Class II obesity. Thus, Class I obesity was the predominant category.

Regarding hemoglobin levels, 31 respondents (43.1%) had low hemoglobin levels, whereas 41 respondents (56.9%) had normal hemoglobin levels. Therefore, most respondents had normal hemoglobin levels.

Bivariate Analysis

Association Between Obesity and Hemoglobin Levels

Table 2. Association Between Obesity and Hemoglobin Levels

Body Mass Index	Low Hemoglobin (n)	Normal Hemoglobin (n)	p-value	Odds Ratio
Class I Obesity	11	30	0.003	0.202
Class II Obesity	20	11		
Total	31	41		

As shown in Table 2, the chi-square statistical test yielded a p-value of 0.003, indicating a statistically significant association between obesity and low hemoglobin levels at the 95% confidence level. The odds ratio (OR) of 0.202 indicates that individuals with Class II obesity had approximately 20.2% of the odds of having normal hemoglobin levels compared with individuals with Class I obesity.

Discussion

Discussion of the Univariate Analysis

In this study, the largest age group consisted of women of reproductive age aged 27–29 years, comprising 29 respondents (40.28%), with a mean age of 25.19 years. Loretta DiPietro (2021, India) reported that the study sample consisted of women of reproductive age aged 15–49 years, representing 57% of the population, with a mean age of 30 years. Women of reproductive age are considered at risk of hemoglobin deficiency because they lose approximately 1.3 mg of iron per day during menstruation. This risk increases when dietary iron intake is insufficient to meet the body's physiological requirements. Furthermore, obesity contributes to an increased risk of anemia because excess adipose tissue disrupts iron metabolism homeostasis, affecting iron availability and utilization during erythropoiesis.

In this study, most women of reproductive age were classified as having Class I obesity, accounting for 56.9% of the respondents. Apriyanti et al. (2020, Kendari) similarly reported that most women of reproductive age were classified as having Class I obesity. These findings indicate a high prevalence of obesity among women of reproductive age. Among this population, the use of hormonal contraceptives, duration of contraceptive use, and dietary patterns have been associated with the occurrence of obesity.

In this study, most women of reproductive age had normal hemoglobin levels, accounting for 56.9% of the respondents. Oki Nor Sahana (2017, Surabaya) similarly reported that most women of reproductive age had normal hemoglobin levels. Women of reproductive age may still have sufficient iron stores to support hemoglobin synthesis, allowing their hemoglobin levels to remain within the normal range.

Discussion of the Bivariate Analysis

This study found a statistically significant association between Class II obesity and low hemoglobin levels. Muhammad Nur Hasan Syah (2022, Jakarta) reported an association between BMI and hemoglobin levels among women of reproductive age with obesity.

Factors contributing to low hemoglobin levels in this population include genetic influences, low physical activity, which may reduce myoglobin levels and iron availability for red blood cell production, unbalanced dietary patterns such as fast-food consumption, alcohol intake, high-calorie diets, and limited consumption of iron-rich foods.

Fonny Kurnia Putri et al. (2023, Padang) also reported that low hemoglobin levels were predominantly found among female university students with Class II obesity. The mean hemoglobin level among students with obesity was lower than that among students with normal nutritional status. Their study identified an association between Class II obesity and low hemoglobin levels. These findings are consistent with the present study, suggesting an association between obese nutritional status and low hemoglobin levels, supported by statistical evidence indicating that women of reproductive age with obesity may have an increased risk of low hemoglobin levels.

In contrast, Ana Khoirun Nisa et al. (2019, Semarang) reported no association between obesity and low hemoglobin levels. However, the present study found a statistically significant association between Class II obesity and low hemoglobin levels. Individuals with obesity may maintain hemoglobin levels within the normal range because the body can compensate for impaired iron absorption c

Similarly, Putu Uci Paramudita et al. (2021, Denpasar) reported no association between obesity and low hemoglobin levels among adolescent girls. In contrast, the present study identified a statistically significant association between Class II obesity and low hemoglobin levels. This discrepancy may be explained by the fact that anemia is not associated solely with BMI but is also influenced by the balance of essential macronutrient and micronutrient intake, including lipids, iron, ascorbic acid, and other nutrients involved in erythropoiesis. Individuals with BMI values below or above the normal range do not necessarily have optimal nutritional status to support hemoglobin biosynthesis and adequate erythrocyte production.

The mechanism linking obesity to anemia can be explained by disturbances in iron metabolism caused by chronic inflammation. In individuals with obesity, excess adipose tissue releases inflammatory substances such as interleukin-6 (IL-6). These inflammatory mediators stimulate increased production of hepcidin, a hormone that regulates iron absorption and distribution in the body. Hepcidin inhibits ferroportin, a protein responsible for transporting iron from storage cells into the bloodstream. Consequently, even when the body has sufficient iron stores, the availability of functional iron for erythropoiesis becomes limited. This process is further exacerbated by oxidative stress resulting from excess fat accumulation, which can damage erythroid cells in the bone marrow and disrupt red blood cell production. In addition, insulin resistance, which frequently occurs in individuals with obesity, may reduce renal erythropoietin synthesis, thereby disrupting erythropoiesis regulation and resulting in insufficient erythrocyte production to meet the body's oxygenation requirements.

Fat accumulation in the liver can also contribute to lipid peroxide formation, disrupting iron metabolism. This process generates free radicals that inhibit hemoglobin synthesis. Consequently, hemoglobin levels decrease, and erythrocytes become smaller, potentially leading to anemia.

Anemia among women of reproductive age requires intensive management. Persistent anemia extending into pregnancy can increase the risk of significant obstetric and perinatal complications, including preterm delivery, low birth weight (LBW), and impaired growth and neurocognitive maturation in newborns. Furthermore, anemia increases the risk of antepartum and intrapartum hemorrhage, potentially compromising maternal hemodynamic stability and fetal well-being. Newborns delivered by mothers with anemia tend to have depleted iron stores, potentially leading to iron-deficiency anemia during the neonatal period

and increasing neonatal morbidity and mortality risks. Therefore, managing anemia during the preconception period is essential to reduce potential adverse outcomes for both mothers and fetuses.

The discussion above demonstrates a statistically significant association between BMI and hemoglobin levels among women of reproductive age with obesity. This finding suggests that higher BMI may be associated with lower hemoglobin levels, potentially affecting health outcomes. The findings are consistent with the research hypothesis.

This study has several limitations. First, it focused exclusively on the association between obesity and hemoglobin levels among women of reproductive age without considering other potentially influential factors, such as dietary patterns, physical activity, genetic factors, contraceptive use, and medical conditions that may affect both obesity and anemia. Second, the study used a limited sample that may not adequately represent the population's demographic diversity, restricting the generalizability of the findings. Therefore, further studies employing multivariate approaches are needed to provide a more comprehensive understanding of the factors influencing the relationship between anemia and obesity in this population.

CONCLUSION

Based on the research findings and discussion presented above, the following conclusions can be drawn:

1. Women of reproductive age aged 20–29 years with obesity in Medan Deli District had a mean age of 25.19 years.
2. A total of 41 women of reproductive age aged 20–29 years in Medan Deli District, Medan City, North Sumatra Province, were classified as having Class I obesity (56.9%).
3. A total of 31 women of reproductive age aged 20–29 years in Medan Deli District, Medan City, North Sumatra Province, were classified as having Class II obesity (43.1%).
4. Among women of reproductive age aged 20–29 years in Medan Deli District, Medan City, North Sumatra Province, 41 respondents (56.9%) had normal hemoglobin levels, while 31 respondents (43.1%) had low hemoglobin levels.
5. A statistically significant association was found between Class II obesity and low hemoglobin levels among women of reproductive age aged 20–29 years in Medan Deli District, Medan City, North Sumatra Province. Women with Class II obesity had 20.2% of the odds of having normal hemoglobin levels compared with those with Class I obesity.

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