



Obesity Indicators and Anemia among Premarital Women of Reproductive Age

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Abstract: Women of childbearing age are a demographic group that is frequently afflicted by nutritional issues, including obesity and anemia. Obesity has been reported to influence the occurrence of anemia. This study aimed to analyze the relationship between obesity indicators and anemia among premarital women of reproductive age. This study used an observational design with a cross-sectional approach. The sample consisted of 102 subjects from undergraduate students aged 18–25 years who were unmarried and had never been pregnant. Obesity indicators were assessed using anthropometric measurements, while anemia status was determined based on hemoglobin (Hb) levels. The results of the bivariate analysis showed a significant association between Body Mass Index (BMI) and body fat percentage with anemia ($p < 0.05$). In contrast, no significant association was found between waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) with anemia ($p > 0.05$). Multivariate analysis showed that body fat percentage was the most significant predictor ($p = 0.032$). Specifically, the obese body fat percentage category exhibited an Odds Ratio (OR) value of 32.8 (95% CI: 1.79–603.40) against the normal category. In conclusion, body fat percentage may serve as a predictor of anemia among premarital women of reproductive age.

Keywords: anemia, body fat percentage, body mass index, obesity, premarital women

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INTRODUCTION

Anemia has been a major public health concern over the past few years in developing countries. Premarital women of reproductive age are the most anemic population group. Not only anemia, but this group is also vulnerable to various nutritional problems, including chronic energy deficiency and obesity (Rachmah et al., 2024). Nutritional problems among premarital women may affect pregnancy processes and outcomes because this group represents the reproductive period of women. Maternal health conditions and nutritional status during pregnancy are largely determined much earlier, before pregnancy or during the premarital age period (Hartanti, 2023).

Iron deficiency anemia remains a major public health problem in Indonesia and many developing countries worldwide. World Health Organization (WHO) reported in 2021 that the global prevalence of anemia among women aged 15–49 years reached 30% (World Health Organization, 2021). Meanwhile, the prevalence of anemia among non-pregnant women aged 15–24 years in Indonesia reached 14.6% in 2023 (Kementerian Kesehatan Republik Indonesia, 2024). Compared with the 2018 Indonesian Basic Health Research, the most recent finding from the Indonesian Health Survey (SKI) in 2023 showed a decreasing trend in anemia prevalence among young women aged 15–24 years in Indonesia, from 32% to 14.6% (Kementerian Kesehatan Republik Indonesia, 2019, 2024).

Several studies have found that obesity among premarital women plays a role in the occurrence of anemia. Various hypotheses have been proposed for the association between obesity and iron deficiency. The nutritional status of women of reproductive age in Indonesia has shown an increasing trend. The prevalence of overweight and obesity (BMI >25 kg/m²) among women aged 20–24 years reached 26.2%. The high prevalence of obesity may lead to an increased prevalence of anemia in this population. According to a study conducted by Maadi (2019), among several factors affecting hemoglobin (Hb) levels in women, energy intake and nutritional status were the two most influential factors for anemia prevalence.

Nutritional status influences the risk of anemia not only through undernutrition but also through overnutrition and obesity. Obesity is characterized by an excessive accumulation of adipose tissue, elevating the risk of various health complications (Hartanti, 2023). A study by Wenzel et al. (2023) demonstrated a significant disparity in anemia status between obese and non-obese women of reproductive age, with obese individuals exhibiting lower means of iron serum, transferrin serum, and hemoglobin levels. These findings suggest that obese women are more susceptible to developing anemia than their non-obese counterparts.

Excess body fat stored in obesity stimulates leptin production, a hormone synthesized by adipocytes. Growing leptin levels subsequently upregulate hepcidin, a key regulatory hormone that inhibits systemic iron absorption. This mechanism induces functional iron deficiency in obese individuals, ultimately contributing to the development of anemia (Al-Mazaideh et al., 2023).

Body Mass Index (BMI) remains the most widely accepted metric for assessing obesity in clinical practice and epidemiological surveys. Conversely, waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) provide critical data regarding body fat distribution and are routinely utilized to identify abdominal obesity. Additionally, body fat percentage reflects

the total mass of subcutaneous and visceral fat. Together, these indicators serve as standard tools for evaluating obesity at both individual and population levels (Ramasamy et al., 2020).

Based on this background, the present study aims to analyze the relationship between various obesity indicators and the incidence of anemia among premarital women of reproductive age.

METHODS

Design, Time, and Place

The study was conducted at Semarang, Central Java, from November 2022 to February 2023. This was an observational study employing a cross-sectional design. Ethical approval was obtained from the Health Research Ethics Committee of Universitas Negeri Semarang (No. 384/KEPK/EC/2022).

Population and Sample

The subjects were 102 female undergraduate students from the Nutrition Study Program, Faculty of Psychology and Health, UIN Walisongo Semarang, selected via consecutive sampling. The inclusion criteria were as follows: aged over 18 years, never married, never pregnant, not currently menstruating when the anemia data was measured, not consuming iron supplements at the time of participation, and having no medical history affecting blood hemoglobin levels.

Research Procedure and Instrument

Obesity indicators, including Body Mass Index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR), were measured using anthropometric tools, while body fat percentage was evaluated using an Omron HBF 514C Body Composition Monitor. A stadiometer, Omron Digital Weight Scale, and Non-stretchable measuring tape were used to measure anthropometric measurements. Anemia status was determined based on hemoglobin (Hb) levels, which were measured photometrically using a Mission Hb check hemoglobin meter. Capillary blood samples were collected from the tip of the middle finger during midday. The BMI and body fat percentage measurements were categorized into underweight, normal, and obese. Meanwhile the measurements of WC, WHR and WHtR were categorized into normal and obese. Iron supplementation and protein source consumption were collected by using questionnaires.

Data Processing and Analysis

The univariate data were presented as proportions, the bivariate data were analyzed using the Chi-square test, and the multivariate data analysis was performed using binary logistic regression via IBM SPSS Statistics version 29.

RESULTS

The findings of this study highlight several key points derived from the univariate and bivariate analyses. The anemia prevalence was 33.3%, as determined by hemoglobin (Hb) levels. Based on specific obesity indicators, the prevalence of obesity among the subjects was 14.7% by BMI, 28.4% by WC, 53.0% by WHR, 35.3% by WHtR, and 26.4% by body fat percentage. In terms of dietary characteristics, only 7.8

% of the subjects routinely consumed iron supplements, and 94.1% consumed an adequately frequent animal protein (≥ 3 servings/day). The data on respondent characteristics are presented in Table 1.

Table 1
Characteristics of Respondents

Characteristics	Total	
	n	%
Iron Supplementation		
Regular (4x/month)	8	7.8
Irregular (<4x/month)	94	92.2
Animal Source Protein Consumption		
Adequate (≥ 3 servings/day)	96	94.1
Inadequate (<3 servings/day)	6	5.9
Anemia Level		
Anemia (< 12 g/dl)	34	33.3
Non-Anemia (≥ 12 g/dl)	68	66.7
BMI		
Underweight (< 18,5 kg/m ²)	21	20.6
Normal (18,5 – 25 kg/m ²)	66	64.7
Obesity (> 25 kg/m ²)	15	14.7
WC		
Normal (≤ 80 cm)	73	71.6
Obesity (>80 cm)	29	28.4
WHR		
Normal (≤ 0.8)	48	47
Obesity (> 0.8)	54	53
WHtR		
Normal (≤ 0.5)	66	64.7
Obesity (> 0.5)	36	35.3
Body Fat Percentage		
Low	10	9.8
Normal	65	63.7
Obesity	27	26.5
Total	102	100

Bivariate analysis using the Chi-square test was performed to examine the relationship between each obesity indicator and anemia status (measured via hemoglobin levels), as presented in Table 2. The bivariate analysis demonstrated a significant relationship between anemia and both body mass index (BMI) and body fat percentage ($p < 0.05$). Conversely, no significant associations were found between anemia and waist circumference (WC), waist-to-hip ratio (WHR), or waist-to-height ratio (WHtR), indicating $p > 0.05$. Among 33 subjects who presented with anemia, more than a quarter of them (27.3%) were classified as underweight by BMI, 69.6% in the normal BMI category, and 3.0% were classified as obese. Furthermore, based on the body fat percentage indicator, 15.1% of the anemic subjects were categorized as obese.

Multivariate analysis performed using binary logistic regression showed that body fat percentage was the most significant predictor ($p = 0.032$), as presented in Table 3. Specifically, the obese body fat percentage category revealed an Odds Ratio (OR) value of 32.8 (95% CI: 1.79–603.40) against the normal category. In conclusion, body fat percentage may serve as a predictor of anemia among premarital women of reproductive age.

Table 2
Correlation Analysis between Obesity Indicators and Anemia

Obesity Indicators	Anemia Status				p value
	Anemia		Non-Anemia		
	n	%	n	%	
BMI					
Underweight	9	27.3	10	14.5	0.038*
Normal	23	69.7	45	65.2	
Obesity	1	3	14	20.3	
WC					
Normal	25	75.7	48	69.6	0.517
Obesity	8	24.3	21	30.4	
WHR					
Normal	15	45.4	32	46.4	0.930
Obesity	18	54.5	37	53.6	
WHtR					
Normal	21	63.6	35	50.7	0.220
Obesity	12	36.4	34	49.3	
Body Fat Percentage					
Low	8	24.2	2	2.9	0.002*
Normal	20	60.7	45	65.2	
Obesity	5	15.1	22	31.9	
Total	33	100	69	100	

*)Indicates statistical significance at $p < 0.05$

Based on binary logistic regression analysis, body fat percentage emerged as the primary determinant of anemia (OR = 32.87; 95% CI: 1.79–603.40; $p = 0.032$). Although the high OR and wide CI reflected sparse data bias due to sample size constraints in specific subgroups, the findings substantively demonstrated a significantly higher risk of anemia in the obese group relative to the normal group. It means individuals in the highest body fat percentage category have a 32-fold higher risk of developing anemia than those in the normal category.

Table 3
Multivariate analysis

Obesity Indicator	B	S. E	Wald	Sig	OR	Lower	Upper
Body Fat Percentage			6.87	0.032*			
Low vs Normal	0.27	0.67	<0.01	0.968	1.03	0.27	3.85
Obesity vs Normal	3.49	1.49	5.53	0.019*	32.87	1.79	603.40
BMI			4.28	0.118			
Underweight vs Normal	1.95	1.20	2.62	0.106	7.00	0.66	73.93
Obesity vs Normal	0.53	1.63	0.11	0.743	1.70	0.07	41.44

*) Indicates statistical significance at $p < 0.05$

DISCUSSION

Based on univariate data, the prevalence of obesity varied across indicators: 14.7% by BMI, 28.4% by WC, 53.0% by WHR, 35.3% by WHtR, and 26.4% by body fat percentage. The findings of this study revealed that 33.3% of the 102 premarital women of reproductive age presented with anemia. Anemia is clinically defined as a condition in which the hemoglobin (Hb) concentration in

the blood falls below normal thresholds. For non-pregnant women of reproductive age, anemia is diagnosed when the blood Hb level is lower than 12 g/dL (World Health Organization, 2024).

Obesity has emerged as a significant factor associated with diminished hemoglobin levels, primarily due to its disruptive impact on systemic iron metabolism. In the current study, among participants from other countries, women with overweight/obesity from Bangladesh were shown to have a lower likelihood of being anemic, while underweight women were more likely to be anemic. However, generally, there is a relation between BMI and anemia among women (Al Kibria, 2021). Meanwhile, research by Nurramadhani et al. (2019) showed that among Indonesian female undergraduate students, 20% of obese women of reproductive age suffered from poor iron status.

This research collectively indicates that overnutrition and obesity represent critical nutritional issues among premarital women, capable of triggering degenerative complications. Research in Korea has highlighted that women of childbearing age are increasingly affected by overnutrition, displaying a simultaneous increase in both BMI-defined overall obesity and waist-circumference-defined abdominal obesity. The findings prove that even though women between 20 and 49 years old represent an active reproductive demographic, the incidence of general obesity (BMI) and central adiposity has risen substantially over recent years, driven by an increasing trend toward sedentary behavior (Nam et al., 2023).

This study analyzed the relationships between these distinct obesity indicators (BMI, WC, WHR, WHtR, and body fat percentage) and anemia status. Our bivariate analysis demonstrated that BMI and body fat percentage were significantly associated with anemia, whereas no significant relationships were found for WC, WHR, and WHtR. This indicates that general adiposity markers, namely BMI and body fat percentage become stronger clinical predictors for anemia risk within this premarital population than abdominal obesity markers. Descriptively, among the anemic subjects, 27.3% were classified as underweight, 69.6% were normal BMI, and 3.0% were categorized as obese. Furthermore, based on body fat percentage, 15.1% of the anemic respondents were classified as obese. When evaluating the obese subgroups independently, the prevalence of anemia reached 24.3% among those with central obesity by WC, 54.5% by WHR, and 36.4% by WHtR.

Many recent studies have shown the link between obesity and iron deficiency across children, adolescents, and adults. An observational study involving 619 women aged 20–49 years reported that iron deficiency was identified in 23.5%, 41.9%, and 45.6% of normal-weight, overweight, and obese women, respectively (Kaner et al., 2016). This persistent state of iron depletion inevitably culminates in nutritional iron deficiency anemia.

Pathophysiologically, obesity expands lipid deposits within adipose tissue. This expansion of adipocytes triggers a corresponding upregulation of the leptin hormone. Elevated circulating leptin, alongside subclinical inflammation, stimulates the overproduction of hepcidin (Saad & Qutob, 2022). As the master systemic regulator of iron homeostasis, hepcidin tightly controls body iron distribution. Increased hepcidin concentrations systematically restrict the influx of iron into the circulatory system by trapping it within iron-exporting cells (Al-Mazaideh et al., 2023).

Although synthesized predominantly in the liver, hepcidin is also expressed at lower levels within adipose tissue. It regulates plasma iron concentrations by binding to ferroportin—the sole transmembrane iron exporter responsible for iron efflux from hepatocytes, macrophages, and

duodenal enterocytes. The binding of hepcidin to ferroportin induces the internalization and subsequent endolysosomal degradation of the exporter. Consequently, cellular iron transport is blocked, duodenal iron absorption from the small intestine is diminished, and circulating serum iron falls. Furthermore, this process restricts macrophages from recycling senescent erythrocyte iron into peripheral circulation and retards iron mobilization from hepatic and splenic storage pools (González et al., 2020).

This complex interaction is fundamentally driven by the chronic, low-grade systemic inflammation characteristic of obesity. Adipose tissue functions as an active endocrine organ that secretes several pro-inflammatory cytokines, including tumor necrosis factor- α (TNF- α) and interleukin-6 (IL-6), the latter of which contributes up to one-third of total circulating IL-6 levels. In overweight and obese individuals, serum hepcidin and IL-6 levels are significantly higher compared to normal-weight counterparts. Hepcidin expression in hepatocytes is directly upregulated by IL-6 via cell signaling pathways. A recent study confirmed that overweight and obese women with central adiposity exhibit higher baseline serum hepcidin, marked inflammatory profiles, diminished iron status, and markedly reduced fractional iron absorption when given oral iron supplementation (Ginzburg, 2019).

High body fat percentage increases anemia risk in women through adipose tissue-driven chronic inflammation. Expanded fat mass secretes IL-6, which stimulates hepatic hepcidin synthesis. Raised hepcidin binds to ferroportin and triggers its degradation, blocking dietary iron absorption in the duodenum and trapping iron inside macrophages, ultimately causing functional iron deficiency and anemia (Nemeth & Ganz, 2023). Consequently, body fat percentage emerges as the primary variable influencing the development of anemia.

CONCLUSION

Body mass index ($p = 0.038$) and body fat percentage ($p = 0.002$) were significantly associated with anemia among premarital women of reproductive age. Conversely, no significant relationship was found between waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) with anemia in this population ($p > 0.05$). Body fat percentage was the most significant predictor of anemia ($p = 0.032$). Individuals in the highest body fat percentage category have 32 times higher risk of developing anemia compared to those in the normal category (OR = 32.87; 95% CI: 1.79–603.40). These findings suggest that BMI and body fat percentage may be useful indicators in anemia risk assessment among women of reproductive age undergoing premarital screening.

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Author Contribution Statement

Dwi Hartanti: Conceptualization, Methodology, Data Analysis, Writing, Project Administration, and Validation. **Dewi Kemuning:** Data Collection and Analysis.

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