

# The Correlation of Body Mass Index and Menstrual Patterns with the Incidence of Anemia in Adolescent Girls

La correlación del índice de masa corporal y los patrones menstruales con la incidencia de anemia en adolescentes

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## SUMMARY

**Introduction:** Anemia in adolescent girls is a significant health problem. Adolescent girls are at a higher risk of anemia due to inadequate nutritional intake and excessive blood loss caused by abnormal menstrual patterns. This study aimed to examine the associations among body mass index (BMI), menstrual patterns, and anemia incidence in adolescent girls.

**Methods:** This study employed a cross-sectional design with a purposive sample of 125 respondents. The independent variables were BMI and menstrual patterns, while the dependent variable was anemia. The study was conducted at a public high school in Surabaya, a city with a high prevalence of anemia

among adolescents, in December 2024. Data were collected through measurements of body weight and height, a menstrual pattern questionnaire, and hemoglobin level examinations using a digital Hb meter. Data analysis was performed using Spearman's Rho test with a significance level of  $<0.05$ .

**Results:** BMI was significantly correlated with anemia incidence among adolescent girls ( $p < 0.001$ ;  $r = 0.481$ ). A significant correlation was also found between menstrual patterns and anemia incidence ( $p < 0.001$ ;  $r = -0.411$ ).

**Conclusion:** BMI and menstrual patterns have a significant correlation with the incidence of anemia in adolescent girls. These findings suggest that healthcare professionals should consider both BMI and menstrual patterns when assessing the risk of anemia in adolescent girls. Adolescent girls with low BMI often have poor dietary habits and misconceptions about proper nutrition in adolescent girls. Abnormal menstrual patterns, such as irregular cycles and prolonged bleeding, can lead to increased blood loss, contributing to anemia. Understanding these correlations can aid early detection and prevention of anemia in adolescent girls.

**Keywords:** BMI, menstrual pattern, anemia, adolescent girls.

DOI: <https://doi.org/10.47307/GMC.2020.128.4.2>

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Recibido: 10 de noviembre 2025

Aceptado: 26 de diciembre 2025

## RESUMEN

**Introducción:** La anemia en las adolescentes es un problema de salud importante. Las adolescentes presentan un mayor riesgo de anemia debido a una ingesta nutricional inadecuada y a una pérdida

*sanguínea excesiva causada por patrones menstruales anormales. Este estudio tuvo como objetivo analizar la correlación entre el índice de masa corporal (IMC) y los patrones menstruales y la incidencia de anemia en las adolescentes.*

**Métodos:** Este estudio empleó un diseño transversal con una muestra de 125 participantes seleccionados mediante muestreo intencional. Las variables independientes fueron el IMC y los patrones menstruales, mientras que la variable dependiente fue la anemia. El estudio se llevó a cabo en un instituto público de Surabaya, ciudad con una alta prevalencia de anemia en adolescentes, en diciembre de 2024. Los datos se recopilaron mediante mediciones de peso y talla, un cuestionario sobre patrones menstruales y exámenes de hemoglobina con un medidor digital. El análisis de datos se realizó mediante la prueba de Rho de Spearman, con un nivel de significancia  $<0,05$ .

**Resultados:** Se observó una correlación significativa entre el IMC y la incidencia de anemia en adolescentes ( $p < 0,001$ ;  $r = 0,481$ ). También se encontró una correlación significativa entre los patrones menstruales y la incidencia de anemia ( $p < 0,001$ ;  $r = -0,411$ ).

**Conclusión:** El IMC y los patrones menstruales presentan una correlación significativa con la incidencia de anemia en adolescentes. Estos hallazgos sugieren que los profesionales de la salud deben considerar tanto el IMC como los patrones menstruales al evaluar el riesgo de anemia en adolescentes. Un IMC bajo suele estar asociado con malos hábitos alimenticios y con conceptos erróneos sobre una nutrición adecuada en las adolescentes. Los patrones menstruales anormales, como ciclos irregulares y sangrado prolongado, pueden provocar una mayor pérdida de sangre, lo que contribuye a la anemia. Comprender estas correlaciones puede ayudar a detectar y prevenir la anemia en adolescentes.

**Palabras clave:** IMC, patrón menstrual, anemia, adolescentes

## INTRODUCTION

Anemia has become a serious health problem worldwide, especially in developing countries, including Indonesia. The incidence of anemia among adolescents in Indonesia is relatively high, with 3-4 out of 10 experiencing anemia (1). Adolescent girls are ten times more likely to develop anemia than boys. Adolescent girls experience monthly blood loss due to menstruation (2,3). Menstruation in adolescent girls places a double burden on their bodies, as they experience rapid growth and also lose blood monthly (4).

Another factor influencing the incidence of anemia in adolescent girls is nutritional status. Nutritional adequacy issues experienced by adolescents are caused by an imbalance between nutritional intake and the body's nutritional needs (5). Adolescent girls with a low Body Mass Index (BMI) who desire a slim body may engage in poor eating habits and hold misconceptions about diet, which can lead to anaemia due to inadequate nutritional intake (6). Adolescent girls with an excessive BMI are also at risk of developing anemia, due to increased iron needs, but iron absorption is impaired due to inflammation caused by obesity (7). The relationship between nutritional status and menstrual patterns, and their association with the incidence of anemia in adolescent girls, remains unclear.

Globally, in 2019, the World Health Organization (WHO) estimated the prevalence of anemia among non-pregnant women aged 15-49 years at 29.9 %, with Southeast Asia having the highest prevalence at 46.5 % (8). According to the 2023 Indonesian Health Survey, the prevalence of anemia among adolescents aged 15-24 years was 15.5 % (Health Development Policy Agency, 2023). The East Java Provincial Health Office estimates that 42 % of adolescent girls in East Java suffer from anemia (9).

Adolescent girls have a unique nutritional and health trajectory, and it is vital to support them in avoiding iron-deficiency anemia. This condition often arises from inadequate nutrition, which can affect girls at both ends of the Body Mass Index (BMI) spectrum (10). Underweight girls may struggle with unhealthy eating habits, sometimes without the proper guidance from healthcare professionals. On the flip side, overweight or obese girls face challenges too, as excess fat can impact iron absorption (11).

Moreover, menstrual patterns significantly influence the risk of anemia in this age group. Suppose we don't tackle the high rates of anemia among adolescent girls. In that case, it can carry on into adulthood, potentially leading to serious health issues like maternal mortality and low birth weight (12). By raising awareness and encouraging healthy habits, we can empower these young women to thrive and ensure a brighter, healthier future.

Adolescent girls are particularly vulnerable to iron deficiency anemia, primarily due to inadequate nutritional intake. Girls with both low and high Body Mass Index (BMI) are at risk of developing this condition (13). Underweight adolescent girls may experience a lack of nutritional intake due to poor eating habits and frequent unhealthy diets, often without the guidance of a doctor or nutritionist (4). Conversely, overweight or obese adolescent girls are also at risk for anemia, as the accumulation of adipose tissue can hinder iron absorption (14).

In addition to nutritional status, menstrual patterns play a significant role in the incidence of anemia among adolescent girls. Suppose the high prevalence of anemia in this group is not effectively managed. In that case, it can persist into adulthood, leading to serious consequences such as maternal mortality, premature births, and low birth weight (15). Adolescent girls are particularly vulnerable to iron deficiency anemia, primarily due to inadequate nutritional intake (16,17).

The Indonesian government has intensified efforts to prevent and address anemia in adolescent girls by prioritizing the provision of iron supplements through schools to meet their iron intake. Sister Calista Roy's adaptation theory describes a system consisting of an input, a process, an effector, and an output. Roy identifies input as a stimulus comprising focal, contextual, and residual stimuli. Nutritional status, as measured by BMI and menstrual patterns, is a key determinant of anaemia incidence in adolescent girls (18). This study aims to examine the relationships among Body Mass Index, menstrual patterns, and anemia incidence in adolescent girls. The objective of the study was to analyse the correlation between body mass index and menstrual pattern with the incidence of anaemia in adolescent girls.

## METHODS

This research was a correlational quantitative study with a cross-sectional design. The population comprised 180 female Grade XI students from a public high school in Surabaya. The inclusion criteria for this study were as

follows: 1) Female students in grade XI at one of the public high schools in Surabaya, 2) Female students who had experienced menstruation, and 3) Students who were present at school during the data collection period. The exclusion criteria included: 1) Female students who were menstruating at the time of the study, and 2) Female students with a history of blood diseases or disorders, such as haemophilia, thalassemia, and thrombocytopenia.

A non-probability purposive sampling technique was used to select the sample. Sampling was determined by selecting a sample from the population that was representative of the research objectives. The sample was determined using the Slovin formula, with 125 respondents.

Demographic questionnaires were used to analyse respondents' characteristics, including age and age at menarche.

The BMI assessment consists of two questions regarding weight, measured in kilograms using a digital weighing scale, and height, measured in meters using a micrometer. The Body Mass Index (BMI) was then calculated using the formula:  $BMI = \text{Weight (kg)} / \text{height (m}^2\text{)}$ . The BMI classification includes the following categories: Severe underweight (< 17.0); Mild underweight (17.0–18.4); Normal (18.5-25.0); Mild obesity (25.1-27.0); and Severe obesity (> 27.0) (P2PTM, Ministry of Health of the Republic of Indonesia, 2019).

The menstrual pattern questionnaire included questions about the menstrual cycle and the duration of each menstrual period. Responses were categorised into two groups: normal and abnormal. A normal menstrual cycle lasts 21 to 35 days, with the period lasting 5 to 7 days. Respondents' anemia status was assessed using a digital hemoglobin (Hb) meter, with results classified into two categories: anemia (Hb < 12 g/dL) and non-anemia (Hb ≥ 12 g/dL).

**Procedure.** Female adolescents who had received parental consent to participate as respondents were gathered in the school hall for data collection, which included interviews on demographic characteristics, menstrual patterns, height and weight measurements, and hemoglobin (Hb) level checks using a digital Hb meter. The examinations were conducted in accordance

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with standard operating procedures and ethical principles.

**Data Analysis.** The collected data were subjected to descriptive and inferential analyses. The descriptive analysis presented a univariate frequency table for BMI, menstrual patterns, and anaemia. The relationships between BMI and menstrual patterns, as well as the incidence of anaemia in adolescent girls, were analyzed

using Spearman’s Rank correlation test at the significance level  $p < 0.05$ .

This research has received ethical approval from the Ethics Commission of the Faculty of Nursing, Airlangga University, on November 19, 2024, with ethical certificate number 3488-KEPK.

RESULTS

Table 1. Demographic Characteristics of Respondents (n=125)

Characteristics	Category	f	%
Age	16 years	56	44.8
	17 years	69	55.2
Age of Menarche	<11 years (fast)	12	9.6
	11-13 years (normal)	105	84.0
	> 13 years (slow)	8	6.4

Table 1 shows that the majority of respondents were 17 years old (69 respondents, 55.2 %) and

most were in the normal menarche age category (11-13 years), with 105 respondents (84 %).

Table 2. The correlation between Body Mass Index and the Incidence of Anaemia in Adolescent Girls (n=125).

Body Mass Index (BMI)	Non Anemia		Anemia		Total	
	f	%	f	%	f	%
Severe underweight	4	3.2	12	9.6	16	12.8
Mild underweight	10	8.0	14	11.2	24	19.2
Normal	40	32.0	11	8.8	51	40.8
Mild obesity	16	12.8	1	0.8	17	13.6
Severe obesity	17	13.6	0	0.0	17	13.6
Total	87	69.6	38	30.4	125	100.0

Spearman's Rho =  $<0.001$ ;  $r = 0.481$

Table 2 shows that the highest number of respondents, 40 (32.0 %), had a normal body mass index and did not experience anaemia. However, 21.1 % of underweight respondents experienced anemia. The results of the bivariate analysis using Spearman’s Rho test showed a significant correlation between body mass index and anemia

( $p < 0.001$ ). This value is significant because the p-value  $< 0.05$  means that the hypothesis can be accepted. The Spearman Rho correlation coefficient of 0.481 indicates a positive, moderate correlation between body mass index and anemia incidence.

Table 3. The correlation between Menstrual Patterns and the Incidence of Anemia in Adolescent Girls (n=125).

Menstrual Pattern	Anemia				Total	
	Non Anemia		Anemia		F	%
	F	%	F	%		
Normal	66	52.8	13	10.4	79	63.2
Abnormal	21	16.8	25	20.0	46	36.8
Total	87	69.6	38	30.4	125	100.0

Spearman's Rho = <0.001; r = -0.411

Table 3 showed that the highest number of respondents had normal menstrual patterns and did not experience anaemia, namely 66 respondents (52.8 %). However, 20 % of respondents with abnormal menstrual patterns experienced anemia. The bivariate analysis using Spearman's Rho showed a significant correlation between the menstrual pattern variable and anemia incidence ( $p < 0.001$ ). This value is significant because the p-value is <0.05, indicating that the hypothesis is accepted. The Spearman's Rho correlation coefficient of -0.411 indicates a negative association between menstrual patterns and anemia incidence, with a moderate magnitude.

## DISCUSSION

There was a respondent with an overweight BMI who experienced anemia. Al Sabbah (2020) stated that individuals with an overweight BMI often consume large amounts of food, but the nutritional quality may be unbalanced. Even with high-calorie intake, if the food consumed is low in iron or other essential nutrients, the risk of anemia may increase. Individuals with an overweight BMI who consume foods with adequate iron content tend to avoid anemia. According to Kumar et al. (19), obesity is often associated with chronic inflammation that can affect iron metabolism. Increased hepcidin levels due to inflammation can inhibit iron absorption, thereby increasing the risk of anemia. However, the level of inflammation and the body's response vary between individuals, which is why not everyone with an overweight BMI experiences anemia.

Roy's adaptation theory highlights that individual adaptation mechanisms can influence nutritional status and the incidence of anemia. Poor eating habits and a misconception about diet indicate a failure in the adaptation process, especially in adolescents with a low BMI. Conversely, balanced nutritional intake among adolescents with a normal BMI reflects the effectiveness of their adaptation mechanisms in maintaining bodily health. Some adolescent girls have self-concepts shaped by social standards that often regard a slim body as a measure of beauty. This perception leads to unhealthy eating habits and to neglect of the body's nutritional needs, including iron. As a result, adolescent girls with a low BMI or underweight are more susceptible to anemia. Adolescent girls do not yet fully understand the impact of a healthy diet and adequate nutritional intake on their health. More comprehensive nutrition education is needed to change adolescent girls' mindsets regarding the importance of nutritional balance and the negative health impacts of an unhealthy diet.

There was a correlation between menstrual patterns and the incidence of anemia in adolescent girls. The more abnormal a person's menstrual pattern, the higher the risk of developing anaemia. Mohammed-Durosinlorun et al. (20) identified menstrual disorders, such as irregular menstrual cycles and prolonged bleeding, which can cause decreased haemoglobin levels, leading to anaemia. Adolescent girls with regular menstrual cycles tend to have higher haemoglobin levels than those with irregular cycles (21). This is because irregular menstrual patterns can cause adolescent girls to experience significant blood loss.

Some respondents with standard menstrual patterns also experienced anemia. One cause of anemia in women with regular menstrual patterns is iron deficiency. Although normal menstruation reduces excessive iron loss, inadequate dietary iron intake prevents the body from meeting its iron requirements for hemoglobin synthesis and red blood cell production, leading to anemia (10).

Abnormal menstrual patterns in adolescent girls can be influenced by various factors, such as stress, weight changes, and excessive exercise (22). Stress can trigger the release of the hormone cortisol, which is regulated by the hypothalamus and pituitary gland. Then the pituitary releases FSH, which stimulates the ovaries to produce estrogen. Suppose there is a disturbance in the FSH and LH hormones. In that case, it can affect estrogen production, which may later lead to menstrual irregularities (20). In this study, the correlation between abnormal menstrual patterns and anaemia incidence in adolescent girls can be explained using Roy's Adaptation Theory. Adolescent girls face challenges adapting to physiological changes, such as hormonal imbalances that affect their menstrual patterns. When the body fails to adapt effectively to blood loss due to irregular and prolonged menstruation, haemoglobin levels decrease, leading to anaemia (3).

Abnormal menstrual patterns, such as irregular cycles and longer-than-usual bleeding, increase the risk of excessive blood loss and affect Hb levels in the body. Given the stress experienced by female students, the exam was held two days after the final-semester exam, in accordance with the research data collection schedule. Exams are crucial for female students, as they significantly affect their learning outcomes. This situation puts pressure on them, triggering stress. This cortisol imbalance can lead to irregular menstruation and increased bleeding, which directly contributes to the risk of anaemia. Education about the importance of stress management and a healthy diet is considered crucial in preventing menstrual irregularities that lead to anaemia.

This study has several limitations: Data were collected at a single school. The questionnaire was completed online using Google Forms, although respondents were gathered directly in the school hall. The instrument used is an assessment from

a subjective individual perspective. Several factors may contribute to the incidence of anemia, including diet, sleep patterns, and caffeine consumption, which can inhibit iron absorption.

## CONCLUSION

Some adolescent girls have hemoglobin levels below 12 g/dL, indicating anemia. There was a significant correlation between body mass index (BMI) and the incidence of anemia in adolescent girls. Girls with a lower BMI are more likely to develop anemia. There was a relationship between menstrual patterns and the incidence of anemia in adolescent girls. Adolescent girls with irregular menstrual patterns, in this case, are at higher risk of anemia. Schools need to cooperate with health workers to provide education, nutrition, and routine anaemia checks, and offer a menu of healthy, nutritious food in the canteen that is easily.

## Acknowledgement

We would like to thank to Research and Community Services Institution of Universitas Airlangga for supporting the study and publication.

## Conflict of interest

The authors wish to confirm that there is no conflict of interest.

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