

The relationship between nutritional status and knowledge with HB levels in adolescent girls

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ARTICLE INFO

Article history:

Received Feb 21, 2026

Revised Feb 27, 2026

Accepted Mar 6, 2026

Keywords:

Adolescent Girls
Anemia
Hemoglobin Levels
Knowledge
Nutritional
Nutritional Status

ABSTRACT

Anemia remains a significant public health problem among Indonesian adolescent girls, as evidenced by prevalence data reaching 32% according to a national health survey. This study aims to analyze the relationship between nutritional status and knowledge with hemoglobin levels in adolescent girls at SMK NU Muara Padang. This study used a quantitative method with a *cross-sectional design* conducted on 52 adolescent girls selected through a *purposive sampling technique*. Data collection included a structured questionnaire to measure nutritional knowledge, anthropometric measurements to determine Body Mass Index, and hemoglobin level examination using a digital *hemoglobinometer*. Statistical analysis was performed using the *Statistical Package for the Social Sciences* version 26 with a *chi-square test* at a significance level of 0.05. The results showed that 67.3% of respondents had insufficient nutritional knowledge, data showed that 55.8% had abnormal nutritional status, and 32.7% had anemia. *Chi-square analysis* revealed no significant relationship between nutritional knowledge and hemoglobin levels ($p = 0.51$), and no significant relationship between nutritional status and hemoglobin levels ($p = 0.14$). Although there was no statistically significant relationship, the high prevalence of anemia and low nutritional knowledge indicate the need for comprehensive interventions. Schools and health facilities should collaborate to implement regular nutrition education programs, anemia screening, and iron supplementation to prevent and manage anemia in adolescent girls.

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INTRODUCTION

Anemia is a global health problem that remains a major challenge, particularly for adolescent girls. The prevalence of anemia among Indonesian adolescent girls is alarming, with data from the 2023 Indonesian Health Survey recording that 18 percent of girls suffer from anemia, an increase from the previous figure of 32 percent in 2018 (Aryanti et al., 2023). This situation indicates that efforts to address anemia in adolescent girls still require serious attention given its broad impact on the quality of future human resources (SW Rahman et al., 2023). Adolescent girls are a vulnerable group to anemia because they experience increased iron requirements due to rapid growth and blood loss during menstruation. Anemia in adolescent girls not only impacts learning concentration and academic achievement but also increases the risk of reproductive health complications in the future, including giving birth to babies with low birth weight and stunting (Janah & Ningsih, 2021). Various factors are known to contribute to the incidence of anemia in adolescent girls, with nutritional knowledge and nutritional status being two important factors that are interrelated in determining hemoglobin status (Utama, 2021).

Adequate nutritional knowledge plays a crucial role in shaping the behavior of consuming a balanced diet among adolescent girls. Research shows that adolescent girls with good nutritional knowledge tend to have higher hemoglobin levels because they better understand the importance of iron intake and nutrients that support hemoglobin formation (Ariana & Fajar, 2024). Furthermore, nutritional status also has a significant influence on the incidence of anemia, where adolescents with an abnormal body mass index, whether thin or obese, have a higher risk of developing anemia than adolescents with normal nutritional status (S. Handayani et al., 2023). This research was conducted at SMK NU Muara Padang, considering that there are not many studies exploring the relationship between nutritional knowledge and nutritional status on hemoglobin levels in adolescent girls in the region. Although iron intake and the menstrual cycle are direct physiological factors affecting hemoglobin levels, this study specifically focused on nutritional knowledge as a behavioral determinant (predisposition) and nutritional status as an accumulative indicator of long-term nutritional adequacy. This approach was chosen to examine the root causes of the problem in a more preventative manner and to address interventions through health education policies in schools. The novelty of this study lies in its comprehensive approach that analyzes two independent variables simultaneously to provide a more complete picture of the factors that influence hemoglobin levels in adolescent girls. By understanding the relationship between nutritional knowledge and nutritional status on hemoglobin levels, it is hoped that more targeted interventions can be formulated to prevent and address anemia in adolescent girls. Based on this background, this study aims to analyze the relationship between nutritional status and knowledge and hemoglobin levels in adolescent girls at SMK NU Muara Padang. The hypothesis of this study is that there is a relationship between nutritional knowledge and nutritional status and hemoglobin levels in adolescent girls at the study site.

RESEARCH METHOD

This study used a quantitative design with a *cross-sectional approach* that aims to analyze the relationship between independent and dependent variables through observations at a specific point in time (Fatmawati & Afiyah, 2024). The study was conducted at SMK NU Muara Padang with a population of all female students aged 15-18 years. The sample determination used a *purposive sampling technique* by considering the inclusion criteria in the form of female students who were willing to be respondents, not undergoing a strict diet program, and present at the time of data collection. While the exclusion criteria included female students who were sick or regularly taking iron supplements. Based on the calculation, a research sample of 52 respondents was obtained who met the research criteria. The data collection instruments consisted of a structured questionnaire to measure the level of knowledge about nutrition and anemia, a digital scale with

an accuracy of 0.1 kg to measure body weight, a *microtoise* with an accuracy of 0.1 cm to measure body height, and a digital hemoglobinometer to measure hemoglobin levels. Measurement of nutritional status was carried out by calculating the Body Mass Index based on the results of weight and height measurements, then categorized into normal and abnormal nutritional status according to WHO standards. Hemoglobin levels were measured using the *cyanmethemoglobin method* and categorized into anemia (Hb levels <12 g/dL) and non-anemia (Hb levels ≥12 g/dL) according to WHO criteria for adolescent girls.

This study has obtained ethical approval from the Health Research Ethics Committee, taking into account the principles of autonomy, *beneficence*, *non-maleficence*, and justice. Each respondent was given a complete explanation of the research objectives and procedures and signed an *informed consent form* before data collection. The confidentiality of respondents' identities and data was strictly maintained in accordance with research ethics. Data analysis was performed using the *Statistical Package for the Social Sciences* version 26 with a significance level of $\alpha=0.05$. Univariate analysis was performed to describe the frequency distribution and percentage of each research variable. Bivariate analysis used the chi-square test to determine the relationship between nutritional knowledge and hemoglobin levels and the relationship between nutritional status and hemoglobin levels. Testing was carried out by comparing probability values (p-values) with a significance level of 0.05, where the relationship is considered significant if the p-value <0.05 (Triana, 2024). The grouping of nutritional status into Normal and Abnormal categories was carried out to avoid bias in the distribution of data in the cross-table cells (Expected Count <5) considering the limited number of samples, and was based on the assumption that underweight and overweight conditions are forms of malnutrition that can physiologically affect iron metabolism and hemoglobin synthesis.

RESULTS AND DISCUSSIONS

This study involved 52 female adolescent respondents at SMK NU Muara Padang who met the established inclusion and exclusion criteria. All respondents (100%) fully participated in the data collection process with no missing data, allowing for comprehensive analysis. Data collection included anthropometric measurements, hemoglobin level checks, and a nutritional knowledge questionnaire.

Frequency Distribution of Nutrition Knowledge Level

The results of the univariate analysis showed that the majority of respondents had inadequate nutritional knowledge. The distribution of nutritional knowledge levels showed that 35 respondents (67.3%) had inadequate knowledge, 15 respondents (28.8%) had adequate knowledge, and only 2 respondents (3.8%) had good knowledge. These data indicate that nutritional knowledge among adolescent girls in the study area still needs to be significantly improved.

Table 1. Frequency distribution of respondents' nutrition knowledge level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	2	3.8	3.8	3.8
	Enough	15	28.8	28.8	32.7
	Not enough	35	67.3	67.3	100.0
	Total	52	100.0	100.0	

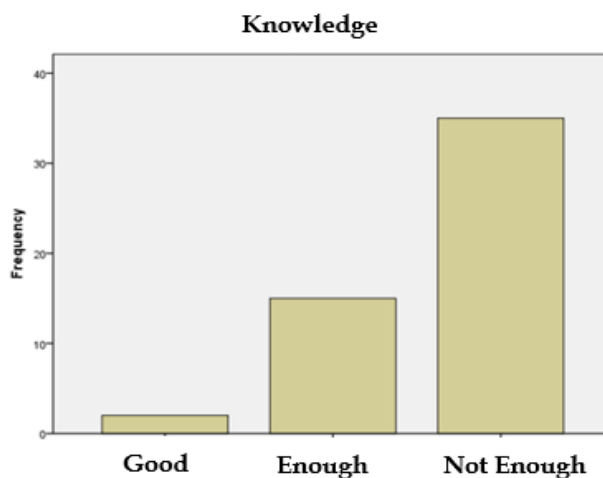


Figure 1. Distribution of nutrition knowledge levels

Distribution of Respondents' Nutritional Status

Mass Index measurements, the distribution of respondents' nutritional status showed that 29 respondents (55.8%) had abnormal nutritional status, while 23 respondents (44.2%) had normal nutritional status. A higher proportion of respondents with abnormal nutritional status indicates nutritional problems that require special attention, either in the form of nutritional deficiencies or excesses that can affect overall health status. The results of hemoglobin level examinations using a digital *hemoglobinometer* showed that 35 respondents (67.3%) had normal hemoglobin levels or did not experience anemia, while 17 respondents (32.7%) experienced anemia with hemoglobin levels below the normal threshold, namely less than 12 g/dL. The prevalence of anemia of 32.7% in this study indicates that anemia is still a significant health problem among adolescent girls.

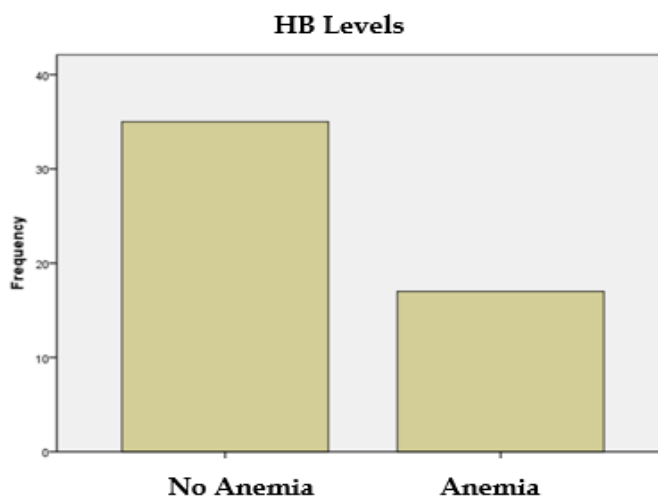


Figure 2. Prevalence of anemia in respondents

The Relationship Between Nutritional Knowledge and Hemoglobin Levels

Bivariate analysis using *chi-square test* was conducted to examine the relationship between the level of nutritional knowledge and hemoglobin levels. The crosstabulation results showed that of the 2 respondents with good knowledge, all (100%) did not experience anemia. In the sufficient knowledge group, 9 respondents (60%) did not experience anemia and 6 respondents (40%)

experienced anemia. Meanwhile, in the poor knowledge group, there were 24 respondents (68.6%) did not experience anemia and 11 respondents (31.4%) experienced anemia. The *chi-square test results* showed a *Pearson Chi-Square value* of 1.361 with degrees of freedom = 2 and a p value (*Asymp. Sig.*) = 0.506. The *Likelihood Ratio value* showed 1.961 with a p value = 0.375, while the *Linear-by-Linear Association test* showed a value of 0.012 with a p value = 0.91. Because the p value > 0.05, it can be concluded that there is no statistically significant relationship between the level of nutritional knowledge and hemoglobin levels in adolescent girls at the research location.

Table 2. Cross tabulation of nutrition knowledge with hemoglobin levels

			HB levels		Total
			No Anemia	Anemia	
Good	Count	2	0	2	
	Expected Count	1.3	.7	2.0	
	% within HB_Rate	5.7%	.0%	3.8%	
Knowledge Enough	Count	9	6	15	
	Expected Count	10.1	4.9	15.0	
	% within HB_Rate	25.7%	35.3%	28.8%	
Not enough	Count	24	11	35	
	Expected Count	23.6	11.4	35.0	
	% within HB_Rate	68.6%	64.7%	67.3%	
Total	Count	35	17	52	
	Expected Count	35.0	17.0	52.0	
	% within HB_Rate	100.0%	100.0%	100.0%	

The Relationship Between Nutritional Status and Hemoglobin Levels

Analysis of the relationship between nutritional status and hemoglobin levels using the *chi-square test* revealed interesting results. Cross-tabulation results showed that of the 23 respondents with normal nutritional status, 13 (56.5%) did not experience anemia, and 10 (43.5%) did. Meanwhile, of the 29 respondents with abnormal nutritional status, 22 (75.9%) did not experience anemia, and 7 (24.1%) did.

The *chi-square test* results showed a *Pearson Chi-Square value* of 2.180 with degrees of freedom = 1 and a p value = 0.14. The *Continuity Correction value* showed 1.390 with a p value = 0.24, while the *Likelihood Ratio* showed a value of 2.179 with a p value = 0.14. *Fisher's Exact Test* produced a p value = 0.23 (2- sided) and 0.12 (1- sided). *Linear-by-Linear Association* analysis showed a value of 2.138 with a p value = 0.14. The *Odds Ratio value* for nutritional status showed 0.41 with a 95% confidence interval ranging from 0.13 to 1.35. Since all p values > 0.05, it can be concluded that there is no statistically significant relationship between nutritional status and hemoglobin levels in adolescent girls.

Table 3. Cross tabulation of nutritional status with hemoglobin levels

			HB levels		Total
			No Anemia	Anemia	
Normal	Count	13	10	23	
	Expected Count	15.5	7.5	23.0	
	% within HB_Rate	37.1%	58.8%	44.2%	
Nutritional status Abnormal	Count	22	7	29	
	Expected Count	19.5	9.5	29.0	
	% within HB_Rate	62.9%	41.2%	55.8%	
Total	Count	35	17	52	
	Expected Count	35.0	17.0	52.0	
	% within HB_Rate	100.0%	100.0%	100.0%	

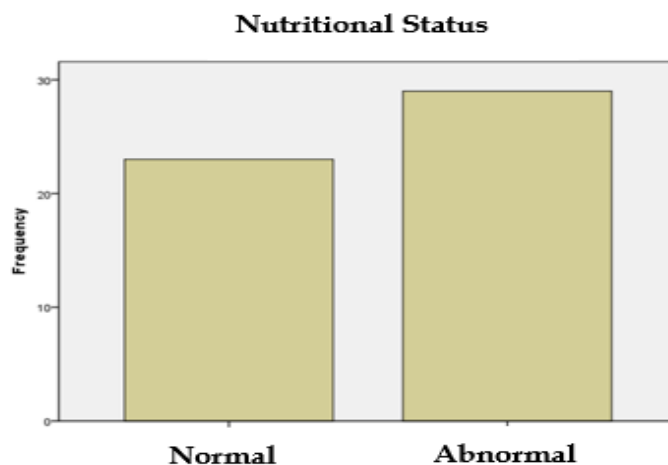


Figure 3. Comparison of anemia status based on nutritional status

The results of the study showed that there was no statistically significant relationship between nutritional knowledge and hemoglobin levels in female adolescents at SMK NU Muara Padang with a p value = 0.51. This finding is in line with the research conducted by Raya & City, (2024) which obtained the result that there was no relationship between knowledge and anemia status in female adolescents with a p value = 0.45. Similarly, a meta-analysis study conducted by Oktaviana, (2025) found that nutrition education did not have a significant effect on increasing hemoglobin levels, although it could increase knowledge about anemia. The same result was also found by R. Damayanti, (2025) which stated that there was no significant relationship between the level of knowledge and the incidence of anemia with a p value = 0.48. However, the findings of this study differ from the results of Fita et al., (2025) who found a significant relationship between nutritional knowledge and the incidence of anemia in female adolescents with a p value = 0.04. This difference in results can be caused by various factors, including differences in sample characteristics, knowledge measurement instruments, and the socio-cultural context of the research location. This indicates that knowledge alone is not enough to influence hemoglobin levels without being accompanied by consistent practices of nutritious food consumption behavior.

This study also found no significant relationship between nutritional status and hemoglobin levels in adolescent girls with a p value = 0.14. This result contradicts the findings of DS Damayanti, (2025) which showed a significant relationship between Body Mass Index *and* hemoglobin levels in adolescent girls with a p value = 0.002. Research by Y. Handayani et al., (2025) also found a significant negative correlation between nutritional status based on BMI values and hemoglobin levels with a p value = 0.007. In addition, research by Febrianti et al., (2023) also found a significant relationship between nutritional status and the incidence of anemia in adolescent girls with p values = 0.02 and p = 0.00. The difference in the results of this study is likely due to the relatively even distribution of nutritional status between normal and abnormal categories, as well as a lower prevalence of anemia in the abnormal nutritional status group. The findings of Nafisa & Rahayu (2023) indicate that nutritional status and hemoglobin levels need to be supported by other supporting tests such as Total Iron Binding Capacity (*TIBC*) for a more accurate diagnosis. A limitation of this study lies in the absence of iron intake and other micronutrients that can directly affect hemoglobin levels, so further research with a more comprehensive approach is needed.

The relationship between nutritional status and knowledge with hemoglobin levels in adolescent girls at SMK NU Muara Padang shows that low levels of knowledge (67.3%) and abnormal nutritional status (55.8%) are the main risk factors for anemia, although statistically in

this study has not shown a significant relationship. The low understanding of iron consumption and unbalanced diet are in line with the findings of research by Harwanto et al. (2024) at MAN Insan Cendikia OKI and research by Prautami et al. (2025) in Menanti Village, where the lack of information makes adolescent girls unaware of the symptoms of anemia and the importance of compliance with consuming Iron Supplement Tablets (ITD). Suboptimal physical condition due to poor nutritional status coupled with low health literacy can inhibit hemoglobin production, so that continuous educational interventions are needed through various information media to improve nutritional behavior and increase adolescent hemoglobin levels as a long-term effort to prevent reproductive health problems and academic achievement.

The phenomenon of the disconnect between nutritional knowledge and hemoglobin levels in this study aligns with the concept of *the knowledge-behavior gap*, a condition in which individuals possess adequate theoretical understanding but do not consistently apply it in daily practice. Adolescent girls who understand the importance of consuming iron-rich foods do not necessarily implement it in their actual diets, given the many mediating factors between knowledge and practice, such as household food availability, peer influence, perception of food taste, and limited pocket money (Syabani Ridwan & Suryaalamshah, 2023). This suggests that health interventions that focus solely on increasing knowledge without addressing behavioral and environmental factors will not produce meaningful changes in hemoglobin status. A study by Yulianti et al. (2024) strengthens this argument by finding that nutritional status, menstrual cycles, and knowledge jointly contribute to the incidence of anemia in adolescent girls, indicating that a multifactorial approach is far more relevant than interventions based on a single variable alone (Yulianti et al., 2024).

Regarding nutritional status, the findings of this study also highlight the complexity of the relationship between *body mass index* (BMI) and hemoglobin levels. Adolescents with abnormal nutritional status, both *underweight* and *overweight*, face the risk of anemia through different pathophysiological mechanisms. In *underweight conditions*, inadequate macronutrient and micronutrient intake directly inhibits erythrocyte production and hemoglobin synthesis. Meanwhile, in *overweight* or obese conditions, chronic *low-grade systemic inflammation* occurs, triggering increased levels of hepcidin, a hormone that regulates iron metabolism and can inhibit intestinal iron absorption and release from tissue depots, ultimately reducing iron availability for erythropoiesis (MJ Rahman et al., 2024). This fact explains why the proportion of anemia in the abnormal nutritional status group in this study was actually lower than in the normal group, namely 24.1% compared to 43.5%, because most respondents with abnormal nutrition were likely in the *overweight category*, where iron reserves are still sufficient even though their biological activity is inhibited.

These findings are further supported by a *cross-sectional study* conducted in Bangladesh by MJ Rahman et al. (2024), which showed that the prevalence of anemia in school-aged adolescent girls is influenced by a complex interaction between knowledge, attitudes, practices, and anthropometric factors, and that knowledge alone without proper practices is insufficient to protect adolescents from anemia (MJ Rahman et al., 2024). Furthermore, a *randomized controlled trial* (RCT) examining the impact of *mobile health* (*mHealth*)-based education on hemoglobin levels in anemic adolescent girls in Bangladesh found that although educational interventions significantly improved knowledge, attitudes, and practices, increases in hemoglobin levels were not always statistically directly proportional to increases in knowledge in the short term (MJ Rahman et al., 2025). This confirms that changes in hemoglobin levels take a longer time and require a combination of education, iron supplementation, and sustainable dietary changes.

The results of this study also highlight the need to develop more comprehensive anemia screening in vocational schools. A study by Abu-Baker et al. (2021) in a *quasi-experimental study* in Jordan demonstrated that a structured one-month nutrition education program significantly improved adolescent girls' knowledge and attitudes toward iron deficiency anemia, although it did

not necessarily result in immediate changes in hemoglobin levels (Abu-Baker et al., 2021). Therefore, an ideal intervention program should include at least three main components: first, ongoing, evidence-based nutrition education using interactive media; second, scheduled and monitored iron supplementation; and third, modifying the school food environment to provide adolescent girls with access to affordable and easily consumed iron-rich foods every day.

The behavioral dimension of food consumption is a crucial aspect that cannot be ignored in efforts to comprehensively understand the incidence of anemia in adolescent girls. Research conducted by Wong et al. (2022) on adolescent girls in urban Kuala Lumpur revealed that although the level of knowledge about iron deficiency anemia in the target group was considered adequate, the practice of consuming iron-rich foods was still very low and inconsistent in daily life. These findings confirm that there is a significant gap between cognitive and behavioral aspects (*cognitive-behavioral gap*) in this group of adolescents, where factors such as taste preferences, eating habits formed since childhood, and social pressure from the social environment contribute significantly to forming actual consumption patterns that do not support meeting daily iron needs (Wong et al., 2022).

This finding is relevant to the condition of respondents in the study at SMK NU Muara Padang, where the majority of respondents with insufficient knowledge (67.3%) were also likely to have suboptimal food consumption practices, although the eating behavior variable was not directly measured in this study. Verma & Baniya (2022) in their study in a remote area of Rajasthan, India, found that the high prevalence of anemia in school-age adolescent girls was closely related to low intake of animal-based iron (*heme iron*) and high consumption of iron absorption inhibitors such as tannins and phytates, which are commonly found in tea, coffee, and cereal-based foods commonly consumed daily (Verma & Baniya, 2022). A similar condition is very likely to occur in adolescent girls at the study site considering the habit of consuming tea and *junk food* that is common among Indonesian students.

From the perspective of social determinants of health, research by Indriyani et al. (2024) identified that anemia in adolescent girls is not solely an individual issue, but rather the result of an interaction between individual factors, family factors, and the health care system. Limited access to health services, low parental involvement in monitoring their daughters' nutritional intake, and the lack of anemia screening programs in vocational schools are structural factors that exacerbate anemia in adolescent girls (Indriyani et al., 2024). Therefore, an effective anemia management strategy requires an approach that not only targets individual adolescent girls but also synergistically involves families, teachers, health workers, and policymakers within an integrated, sustainable, and measurable intervention *framework* through valid and reliable health indicators.

The dominance of overweight respondents in the abnormal nutritional status category has biological implications in the form of disturbances in iron metabolism due to low-grade chronic inflammatory conditions. Obesity or overweight conditions trigger an increase in the hormone hepcidin which inhibits iron absorption in the intestine and locks iron reserves in the tissue, so that the iron is not biologically available for hemoglobin formation (erythropoiesis) even though intake may be sufficient. This explains the unique phenomenon in this study where the abnormal nutritional status group actually had a lower prevalence of anemia (24.1%) compared to the normal nutritional status group (43.5%), because most of the abnormal respondents were likely in the overweight category who still had sufficient iron reserves but experienced impaired bioavailability.

CONCLUSION

Based on the results of statistical analysis using the *chi-square test* on 52 female adolescent respondents at SMK NU Muara Padang, this study concluded that there was no statistically significant relationship between the level of nutritional knowledge and hemoglobin levels ($p = 0.51$). Similarly, no significant relationship was found between nutritional status and hemoglobin

levels in female adolescents ($p = 0.14$). The prevalence of anemia in respondents reached 32.7% with the majority of respondents having nutritional knowledge in the poor category (67.3%) and abnormal nutritional status (55.8%). Although both independent variables did not show a significant relationship with hemoglobin levels, the high prevalence of anemia and low nutritional knowledge indicate the need for comprehensive interventions in efforts to prevent and overcome anemia in female adolescents.

This study shows that low nutritional knowledge (67.3%) and abnormal nutritional status (55.8%) are indeed risk factors, but do not always have a statistically significant linear relationship with hemoglobin levels. This contributes to the anemia determinant model that increasing knowledge alone is not enough without being accompanied by consistent changes in dietary consumption practices, and confirms that abnormal nutritional status (both underweight and overweight) has a complex pathophysiological mechanism in influencing iron bioavailability. Therefore, this study concludes that an ideal anemia determinant model should integrate other, more comprehensive variables such as iron intake, menstrual cycle, and supplementation adherence to obtain a more accurate picture of anemia status.

Based on the findings of this study, it is recommended that schools intensify nutrition education programs through regular counseling on the importance of consuming a balanced, nutritious diet and iron supplementation. Local community health centers are expected to collaborate with schools in conducting routine anemia screening and monitoring the nutritional status of adolescent girls. Further research is recommended to explore other variables that have a greater influence on hemoglobin levels, such as iron intake, diet, menstrual cycle, and adherence to iron supplementation, using a longitudinal study design and more comprehensive laboratory tests, including *Total Iron Binding Capacity*, to obtain a more accurate picture of anemia status.

ACKNOWLEDGEMENTS

The author expresses his deep appreciation to the Principal of SMK NU Muara Padang who has given permission to carry out the research, all female students who were willing to be research respondents, health workers who helped with hemoglobin level examinations, and all parties who have contributed to the smooth running of this research.

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