Original Article

# Effectiveness of Honey Soy Milk on Hemoglobin Improvement among Adolescent Girls with Menstrual Anemia: A Quasi-Experimental Study

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## ABSTRACT

***Background:*** Anemia is a common health problem among adolescent girls, primarily due to iron deficiency and blood loss during menstruation. Honey contains bioactive compounds beneficial to health, including the improvement of metabolism and hematological status. This study aims to determine the effect of honey soy milk on hemoglobin (Hb) levels among adolescent girls with menstrual anemia.

***Methods:*** This quantitative study employed a quasi-experimental design with one group pretest–posttest, conducted at an educational institution in Indonesia. A total of 25 adolescent girls with menstrual anemia were selected using purposive sampling based on inclusion and exclusion criteria. The intervention consisted of administering 200 mL of honey soy milk twice daily for 5 consecutive days during menstruation. Hemoglobin levels were measured in g/dL using an EasyTouch GCHb digital analyzer before and after the intervention. Data analysis followed the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guidelines.

***Results:*** The mean hemoglobin level before the intervention was 11.15 ± 1.72 g/dL, and after the intervention, it increased to 12.92 ± 1.87 g/dL. Statistical testing showed a significant difference ($p < 0.001$), indicating that honey soy milk effectively improved Hb levels among participants.

***Conclusion:*** Honey soy milk is effective in increasing hemoglobin levels in adolescent girls with menstrual anemia. These findings support the use of functional foods as an adjunctive strategy in anemia prevention and management programs for adolescents

***Keywords***: Adolescent; Anemia, Iron-Deficiency; Hemoglobins; Soy Milk.

## Implications for Practice:

- Honey soy milk administration can serve as a simple nutritional intervention to increase hemoglobin levels among adolescent girls experiencing menstrual anemia.
- Functional foods such as soy milk and honey may be considered as complementary options in anemia prevention programs within schools and adolescent health services.
- These findings support the role of health workers, particularly nurses and midwives, in recommending honey soy milk as part of nutrition education, while also informing public health policies aimed at developing natural nutrition-based strategies to reduce anemia prevalence among adolescents.

## Introduction

Adolescence, defined by the World Health Organization (WHO) as the period between 10 and 19 years of age, represents a transitional stage marked by rapid physical, psychological, and social development. During this critical phase, adolescents experience a significant increase in nutritional demands due to accelerated growth, hormonal changes, and the onset of reproductive maturity. The quality of adolescent health during this period serves as a key determinant of well-being and productivity in adulthood, shaping the future human resource potential of a nation (Bhui et al., 2023). However, despite global efforts to promote adolescent health, nutritional deficiencies, particularly anemia, remain one of the most persistent and concerning health problems among adolescent girls.

Anemia, especially iron deficiency anemia (IDA), is a widespread condition that results from an imbalance between iron intake, iron losses, and the body's increased requirements during adolescence. It is characterized by reduced hemoglobin (Hb) concentration and diminished oxygen-carrying capacity of the blood, leading to symptoms such as fatigue, impaired cognitive function, and reduced physical endurance. The WHO (2023) estimates that approximately 29.9% of women of reproductive age globally suffer from anemia, with the highest prevalence found among adolescent girls. In low- and middle-income countries, this rate can exceed 40%, classifying it as a moderate to severe public health concern. In Indonesia, the prevalence remains alarmingly high at around 32% (Riskesdas, 2023), indicating that despite national iron supplementation programs, dietary patterns and health behaviors continue to limit the effectiveness of anemia prevention efforts.

The consequences of anemia in adolescence extend beyond immediate health effects. Several studies have shown that anemia negatively affects school attendance, learning concentration, and academic performance, thereby reducing the potential productivity of future generations (Sari, Judistiani, et al., 2022). Moreover, chronic anemia during adolescence can impair immune function, slow growth, and increase the risk of complications during future pregnancies ; .

From a public health perspective, this condition also contributes to a cycle of malnutrition and poor maternal health outcomes, particularly in countries where adolescent marriage and early childbirth remain prevalent. Therefore, addressing anemia in adolescent girls is a strategic investment in human capital development and future economic productivity.

The WHO (2021) recommends a dual approach in managing anemia—pharmacological interventions, such as iron supplementation, and non-pharmacological strategies, which focus on improving dietary quality and nutrient bioavailability. While supplementation can rapidly improve Hb levels, its sustainability is often limited by side effects, poor adherence, and low awareness. Hence, non-pharmacological approaches through functional and natural foods are increasingly encouraged, as they are culturally acceptable and have fewer adverse effects. In this context, soy milk emerges as one of the most promising plant-based protein sources. It contains iron, protein, calcium, and B vitamins, which are essential for erythropoiesis and hemoglobin synthesis (Kumar et al., 2022; Nolden & Forde, 2023; De & Goswami, 2022). Empirical studies have shown that soy-based foods can help improve hematological parameters and reduce anemia prevalence in young populations (Hu et al., 2024).

In addition to soy, honey is recognized as a natural functional food with high nutritional and medicinal value. It contains bioactive compounds such as flavonoids, polyphenols, iron, magnesium, folic acid, and vitamin C, which play a direct role in red blood cell formation and immune enhancement (Abdullah et al., 2024). Moreover, honey's antioxidant, anti-inflammatory, and antimicrobial properties help maintain cellular stability and support hematopoiesis (Ilia et al., 2021). Recent findings demonstrate that moderate, regular consumption of honey can increase hemoglobin levels and hematocrit values, making it a valuable dietary supplement in populations at risk of anemia (Christa et al., 2023). When combined with soy milk, honey not only enhances palatability and nutrient density but may also synergistically improve iron absorption and erythropoiesis efficiency.

Despite growing evidence supporting the individual benefits of soy milk and honey, research combining both ingredients as a single functional intervention remains extremely limited, especially among adolescent girls with menstrual anemia. Most previous studies investigated the effects of either soy milk or honey in isolation (Berg & McCarthy, 2022; Sugiarsih et al., 2023; Hussein & Kadhem, 2025), leaving an important research gap in understanding their combined efficacy. This gap is significant because the co-administration of soy milk and honey potentially offers complementary effects: soy provides high-quality plant protein and essential amino acids required for erythrocyte synthesis, while honey contributes bioavailable micronutrients that enhance iron utilization. Hence, empirical evidence is needed to verify whether the combination of honey and soy milk (Honey Soy Milk, or HSM) can produce a measurable improvement in hemoglobin levels compared to individual consumption.

The theoretical foundation of this study lies in the nutrient–erythropoiesis–hemoglobin model, which conceptualizes the process of hemoglobin formation as dependent on the adequate availability of macro- and micronutrients. Iron serves as the central element in heme synthesis, while proteins and amino acids support the structural development of erythrocytes. Micronutrients such as vitamin C, folate, and vitamin B12 act as cofactors that facilitate iron absorption and red blood cell maturation (Mekuria, 2022). In this framework, the integration of honey and soy milk provides a balanced nutritional composition that supports each stage of erythropoiesis, from nutrient intake and bone marrow stimulation to hemoglobin production. The combination of these two functional foods thus represents a biologically plausible and culturally appropriate non-pharmacological approach to improving adolescent anemia (Hardiansyah et al., 2024; Fekete et al., 2025).

Based on this rationale, the present study aims to analyze the effectiveness of honey soy milk administration in increasing hemoglobin levels among adolescent girls with menstrual anemia. It is hypothesized that regular consumption of honey soy milk during menstruation significantly increases hemoglobin levels by stimulating erythropoiesis and improving iron utilization. This study is expected to contribute meaningful evidence to adolescent nutritional health literature and provide practical implications for the development of sustainable, community-based strategies for anemia prevention in young women.

## Methods

### Study Design

This study employed a quantitative approach with a quasi-experimental one-group pretest–posttest design, following the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) Statement guidelines (Abdi et al., 2025). This design was selected because it allowed the researchers to evaluate changes in hemoglobin (Hb) levels and body weight among participants before and after the honey soy milk intervention without the need for a control group. The absence of a control group was justified by the ethical consideration of not withholding potentially beneficial nutritional supplementation from participants. The study was conducted over a four-month period, from April to July 2024, at the Female Student Dormitory of IKesT Muhammadiyah Palembang, Indonesia, where the structured academic environment supported consistency and participant engagement throughout the data collection process.

## Participants

The study population consisted of adolescent girls who had experienced menarche. Inclusion criteria were having menstruated, willingness to participate until study completion, and ability to cooperate during the intervention. Exclusion criteria included adolescents with comorbidities and those currently taking iron supplements or blood-boosting tablets. Participants were selected using purposive sampling based on screening for mild to moderate menstrual anemia, resulting in 25 eligible adolescents who met the criteria. All participants received a clear explanation of the study objectives and procedures and provided written informed consent prior to participation. No financial compensation was provided

## Instruments

The instruments used in this study were adopted and adapted tools for measuring hemoglobin levels and collecting participant characteristics. Hemoglobin (Hb) concentration was measured using the EasyTouch® GCHb digital analyzer, a portable point-of-care device for capillary blood hemoglobin assessment that has demonstrated good validity and reliability, with an accuracy of ±0.1 g/dL and strong agreement with standard laboratory hematology analyzers (Taha et al., 2025). The device was calibrated according to the manufacturer's instructions before each measurement session to ensure accuracy.

A structured interview questionnaire was used to collect sociodemographic and biological data, including age, body weight, menstrual history, and nutritional status. The questionnaire was adapted from an adolescent health assessment instrument developed by the Indonesian Ministry of Health and reviewed by experts to ensure content validity (CVI = 0.92). Permission to use and adapt both instruments was obtained through institutional ethical approval (WHO, 2011).

## Intervention

Participants received 200 mL of honey soy milk twice daily for five consecutive days during menstruation, with a soy-to-honey ratio of 3:1. The honey soy milk was prepared daily using locally sourced soybeans and pure honey to maintain freshness and nutrient quality, following standard soy milk processing procedures described in previous studies (Olías et al., 2023). Soybeans were soaked overnight, boiled for approximately 30 minutes, and filtered, after which honey was added at a temperature of approximately 40°C to preserve its bioactive compounds (Ilia et al., 2021).

Consumption was supervised to ensure adherence, and dietary intake was controlled by instructing participants to maintain their usual diet and avoid iron supplements or fortified products, consistent with recommendations for nutritional intervention studies assessing hemoglobin outcomes (Lee, 2020). Post-intervention hemoglobin measurements were conducted using the same device and protocol as the pretest to ensure data consistency.

## Data Collection

Data were collected using structured interview forms and laboratory measurements. Hemoglobin (Hb) levels were measured in grams per deciliter (g/dL) using an EasyTouch® GCHb digital analyzer, a point-of-care hemoglobin testing device suitable for field-based nutritional studies (Olawade et al., 2025). Capillary blood samples were obtained from the fingertip using sterile disposable lancets and microcuvettes, following standardized procedures for capillary hemoglobin assessment in adolescents (An et al., 2021).

All Hb measurements were conducted at the participants' dormitory in a clean and well-ventilated room under the direct supervision of trained nursing students. To reduce diurnal and dietary variation, hemoglobin assessment was performed in the morning before food or supplement intake, as recommended in hematological measurement protocols (Lee, 2020). The same device and standardized procedure were used for both pretest and posttest measurements, and the analyzer was calibrated before each session according to the manufacturer's instructions.

Participant safety was ensured throughout the data collection process. Adolescents with Hb levels below 8 g/dL were excluded from the intervention and referred for further clinical evaluation, consistent with international anemia management guidelines (Kumar et al., 2022). Demographic data were collected through structured interviews, and participant confidentiality was maintained using unique identification codes. Hemoglobin measurements were conducted twice for each participant, and the mean value was used for analysis to enhance measurement reliability (Sari, Judistiani, et al., 2022).

### Data Analysis

Data were analyzed using IBM SPSS Statistics version 25.0. Univariate analysis was conducted to describe participant characteristics, while paired sample t-tests were used to assess changes in hemoglobin levels and body weight before and after the intervention (Polushkina-Merchanskaya et al., 2025). Effect size was calculated using Cohen's d to determine the magnitude of the intervention effect. The validity of the analysis was ensured through independent verification of the statistical outputs by two members of the research team (Althubaiti, 2023).

### Ethical Considerations

The study received ethical approval from the Health Research Ethics Committee of IKesT Muhammadiyah Palembang (Approval No. 000190/KEP IKesT Muhammadiyah Palembang/2024) and adhered to the principles outlined in the Declaration of Helsinki. Research funding was provided by the University of Muhammadiyah Ahmad Dahlan Palembang under Grant Agreement No. 1543/KEP/II.3.AU/F/2023. All participants provided written informed consent after receiving a detailed explanation of the study's objectives, procedures, and confidentiality measures. Participant identities were coded to maintain anonymity and data privacy throughout the research process

## Results

A total of 86 adolescent girls were initially screened based on the inclusion and exclusion criteria. After applying the selection criteria and hemoglobin screening, 25 respondents met the eligibility requirements and completed the entire study process. All participants were senior high school students residing in the dormitory of IKesT Muhammadiyah Palembang, ensuring similar daily routines, diet, and environmental exposure.

The adolescent period represents a critical stage of rapid growth and hormonal change that increases nutritional requirements, particularly for iron and protein, which are essential for hemoglobin synthesis. Therefore, understanding participants' demographic and biological characteristics is important to ensure the comparability of baseline conditions and to minimize confounding variables. The demographic characteristics of the study participants are presented in **Table 1**.

**Table 1.** Demographic and Biological Characteristics of Participants

| Variable | Category | n | Percentage% |
|---|---|---|---|
| **Age (years)** | 15 | 6 | 24.0 |
| | 16 | 10 | 40.0 |
| | 17 | 7 | 28.0 |
| | 18 | 2 | 8.0 |
| **Age at menarche (years)** | ≤12 | 14 | 56.0 |
| | >12 | 11 | 44.0 |
| **Body Mass Index (BMI)** | Underweight (<18.5) | 5 | 20.0 |
| | Normal (18.5–24.9) | 20 | 80.0 |
| **Duration of menstruation (days)** | ≤4 | 6 | 24.0 |
| | 5–6 | 15 | 60.0 |
| | ≥7 | 4 | 16.0 |
| **Menstrual cycle regularity** | Regular | 18 | 72.0 |
| | Irregular | 7 | 28.0 |
| **Residence status** | Dormitory | 25 | 100.0 |
| **Education level** | Senior high school | 25 | 100.0 |

As shown in **Table 1,** the participants were predominantly 16 years old (40%), representing mid-adolescence—a phase where nutritional and hormonal fluctuations are common. More than half (56%) had experienced menarche at or before the age of 12, indicating early onset of reproductive maturity. Most respondents (80%) had a normal body mass index, suggesting that the majority maintained adequate nutritional intake, while 20% were classified as underweight, reflecting potential dietary deficiencies that could influence hemoglobin levels.

The average duration of menstruation ranged from five to six days for 60% of participants, consistent with normal menstrual patterns. A total of 72% of respondents reported regular menstrual cycles, indicating relatively stable reproductive physiology. Because all participants lived in the same dormitory environment and shared similar school meal schedules, variations in diet and activity were minimal. This homogeneity among participants helped reduce external bias and allowed a clearer assessment of the intervention's effect on hemoglobin levels.

*Dysmenorrhea Screening Results*

Before the intervention, dysmenorrhea screening was carried out as part of the respondent selection process. Screening was carried out using a questionnaire with seven questions that measured the intensity of menstrual pain and its impact on daily activities, such as studying, exercising, and social interaction.

The screening results showed a variation in dysminorea scores between 3 and 6, with an average value ranging from 42.86%–85.71%. Respondents with a score of ≥4 were selected as the study sample because they showed more pronounced symptoms of dysminorea and were considered relevant to the study objectives. The majority of respondents experienced moderate to severe symptoms of dysmenorrhea, which has the potential to reduce the quality of life of adolescent girls, including study concentration and daily productivity. The distribution of screening results is presented in the following table:

**Table 2.** Distribution of Dysminorea Screening Results of Research Respondents

| Skor Sminors | Number of Respondents | Percentage (%) | Category |
|---|---|---|---|
| 3 (42,86%) | 2 | 8.0 | Mild |
| 4 (57,14%) | 13 | 52.0 | Moderate |
| 5 (71,43%) | 7 | 28.0 | Moderate–Severe |
| 6 (85,71%) | 3 | 12.0 | Severe |
| Total | 25 | 100 | |

From the **table 2**, it can be seen that most of the respondents were in the medium (52%) and medium-heavy (28%) categories, with a small percentage in the heavy (12%) and light (8%) categories. These findings show that the majority of adolescent girls who participated in the study experienced complaints of menstrual pain that were quite annoying.

*Hemoglobin Values Before Intervention*

Baseline measurements of hemoglobin (Hb) levels were conducted prior to the administration of the honey soy milk intervention to determine the initial hematological status of the participants. The examination was carried out on 25 adolescent girls who had been selected through the dysmenorrhea screening process. The mean Hb level before the intervention was 11.15 ± 1.72 g/dL, with values ranging from 8.0 to 15.0 g/dL, indicating that most participants had mild anemia according to WHO classification standards. This mean value is below the normal threshold for adolescent girls (≥12 g/dL), reflecting suboptimal iron status and a need for nutritional intervention. (**Table 3**)

These findings align with national epidemiological data showing a high prevalence of anemia among Indonesian adolescent girls (approximately 48.9%), consistent with global WHO data indicating that anemia affects over 30% of adolescent girls worldwide. Adolescents are particularly vulnerable due to increased physiological iron requirements during menstruation combined with inadequate dietary iron intake. This condition may lead to reduced learning concentration, lower physical fitness, and potential reproductive health problems in the future.

Thus, the baseline results reinforce the appropriateness of applying a quasi-experimental one-group pretest–posttest design, since the participants' initial hematological status demonstrated a genuine anemia problem requiring a functional nutrition-based intervention such as honey soy milk. The normality of Hb distribution was tested using the Shapiro–Wilk test ($p > 0.05$), indicating that the data were normally distributed and suitable for parametric statistical analysis using a paired sample t-test at $\alpha = 0.05$.

**Table 3.** Baseline Hemoglobin Levels (Pre-test, N = 25)

| Parameter | Mean ± SD (g/dL) | Min | Max |
|---|---|---|---|
| Hb Level | 11.15 ± 1.72 | 8.0 | 15.0 |

**Table 4.** Respondents' Hemoglobin Values Before Intervention

| Parameter | Value |
|---|---|
| Mean | 11.15 g/dL |
| Minimum | 8 g/dL |
| Maximum | 15 g/dL |
| Standard Deviation (SD) | 1.72 g/dL |

Based on **Table 4,** the distribution of Hb levels of respondents shows that there are groups in the category of mild to moderate anemia. This strengthens the basis for the need for intervention in the form of honey soy milk selected in this study, because the combination of soy and honey is believed to be able to increase iron metabolism and improve hemoglobin levels. With this clear baseline, the effectiveness of the intervention can be objectively measured at the post-test stage.

*Hemoglobin Values After Intervention*

The research intervention in the form of giving honey soy milk was carried out on 25 adolescent girls who had passed the dysminoria screening process. The intervention is given during the menstrual period with the aim of increasing hemoglobin (Hb) levels while preventing the risk of anemia emergencies.

Simple laboratory test results after the intervention showed an increase in Hb levels in most respondents. The mean Hb value from 11.15 g/dL at the initial measurement (pre-test) increased to 12.92 g/dL at the post-test measurement. The range of post-intervention Hb values ranged from 10 g/dL to 15.8 g/dL, with a standard deviation of 1.87.

This average increase in Hb of more than 1.7 g/dL indicates a significant improvement in hematological status in a relatively short time. This strengthens the suspicion that the bioactive content in honey soy milk, such as soy isoflavones and antioxidant compounds from honey, plays a role in increasing iron metabolism and improving erythropoiesis (red blood cell formation).

**Table 5.** Hemoglobin Values Before and After Intervention (N = 25)

| Variabel | Mean (g/dL) | Min | Max | SD |
|---|---|---|---|---|
| Pre-test | 11.15 | 8 | 15 | 1.72 |
| Post-test | 12.92 | 10 | 15.8 | 1.87 |

**Table 5** shows a shift in the distribution of respondents' Hb values for the better after the intervention. If before the intervention most adolescents were in the category of mild to moderate anemia, then after the intervention most had reached values close to or even exceeded the normal Hb limit for adolescent girls (≥12 g/dL).

*Statistical Test of Pre and Post Intervention Differences*

To ensure that the increase in Hb levels did not occur by chance, a statistical paired sample t-test was carried out. The results of the analysis showed a value of $t = -5.167$ with a p-value = 0.001 ($p < 0.05$). These findings prove a statistically significant difference between Hb levels before and after the intervention.

These results are in line with the quasi experiment one group pretest-posttest research design, which aims to assess changes in Hb status in a single group without external control. A significant increase in Hb levels after the intervention indicated that honey soy milk had a noticeable effectiveness in helping to address the problem of anemia in adolescent girls.

In addition to being relevant to the research abstract, these findings also strengthen the theoretical foundation that soy- and honey-based functional foods can be an alternative strategy for preventing anemia among adolescent girls. This is important considering that this group is a generation of mothers-to-be, so their nutritional and hematological status is closely related to the health of pregnancy and fetuses in the future.

**Table 6.** Paired Sample t-test test results Hb level (N = 25)

| Variabel | t | p-value | Information |
|---|---|---|---|
| Pre–Post Hb | -5.167 | 0.001 | Significant ($p < 0.05$) |

Thus, it can be concluded that the administration of honey soy milk significantly increases Hb levels in adolescent girls with menstrual anemia, and has the potential to be one of the simple, affordable, and easily applied nutritional interventions in the school and household environment (**Table 6**).

## Discussion

Anemia remains one of the most prevalent public health problems globally, particularly among adolescent girls who are physiologically vulnerable due to regular menstrual blood loss. This monthly cycle increases iron requirements, and when not adequately met through diet, can lead to decreased hemoglobin (Hb) synthesis and impaired oxygen transport capacity. In this study, the mean Hb level before the intervention was 11.15 ± 1.72 g/dL, indicating that most participants experienced mild to moderate anemia. This finding aligns with the World Health Organization (2023) report, which states that anemia affects more than one billion people worldwide, with adolescent girls among the most at-risk populations due to dietary insufficiencies and menstrual blood loss (Warner & Weyand, 2022).

After the administration of honey soy milk for five consecutive days during menstruation, the average Hb level increased significantly to 12.92 ± 1.87 g/dL ($p < 0.001$). This statistically significant improvement demonstrates that functional foods based on local ingredients can effectively enhance hematological status. The result supports the findings of Olías et al. (2023) and Kim (2021), who reported that soy-based drinks and honey consumption can synergistically improve iron metabolism and hemoglobin formation. Soybeans provide high-quality protein and essential amino acids necessary for erythropoiesis, while honey contributes bioactive compounds such as iron, folate, and vitamin C that facilitate hemoglobin synthesis (Sasi et al., 2023).

Physiologically, the mechanism underlying the increase in hemoglobin can be explained by the synergistic effect of soy protein and honey's micronutrients. Soy protein contains amino acids such as glycine and histidine that serve as building blocks for heme synthesis, while honey's vitamin C and polyphenolic compounds enhance the absorption of non-heme iron in the gastrointestinal tract by reducing ferric ($Fe^{3+}$) to ferrous ($Fe^{2+}$) iron, which is more bioavailable (Mayer Labba et al., 2022). Additionally, honey's antioxidants (flavonoids and phenolic acids) protect erythrocyte membranes from oxidative stress, extending red blood cell lifespan and improving overall hematological function. These mechanisms are consistent with Fitripancari et al., who emphasized that plant-based iron sources require co-factors such as vitamin C to optimize bioavailability and absorption efficiency (Fitripancari et al., 2023).

The present findings also resonate with global evidence. Asrida et al. (2022) found that regular honey consumption improved hemoglobin levels and reduced oxidative stress among mildly anemic women. Similarly, Hu et al. (2024) reported that soy protein supplementation significantly enhanced erythropoiesis through increased iron retention and erythrocyte regeneration. A related study by Eichler et al. (2019) demonstrated that soy-based milk enriched with micronutrients effectively increased Hb levels among adolescent girls in Southeast Asia. Together, these studies reinforce the theoretical framework that a combination of plant-based proteins and natural antioxidants can promote hematopoiesis and restore iron homeostasis.

From a theoretical perspective, this study provides empirical evidence supporting the nutritional synergy model, where the interaction between macronutrients (protein) and micronutrients (vitamin C, iron, polyphenols) optimizes metabolic and hematopoietic outcomes. This strengthens existing nutritional theories on the role of functional foods in improving non-heme iron absorption and supports the application of dietary diversity in anemia prevention programs (Martiniakova et al., 2022; Sharma, 2024). Practically, these findings demonstrate that honey soy milk can serve as a feasible, cost-effective, and culturally acceptable school-based nutritional intervention for adolescent girls.

This study's implications are significant for the public health and education sectors. For community health workers and school nutritionists, honey soy milk can be integrated into adolescent nutrition programs as a complementary intervention to iron supplementation. Schools can collaborate with local health offices to establish a "Healthy Menstrual Nutrition Program", which includes the provision of honey soy milk during menstruation to improve students' concentration, stamina, and well-being. For policymakers, the results highlight the importance of incorporating functional food-based strategies into national anemia prevention programs targeting adolescents, especially in areas with limited access to animal-based protein sources.

However, this study has limitations. The small sample size (n = 25) and purposive sampling limit the generalizability of results. The absence of a control group also restricts causal inference, though the pretest–posttest design provided strong within-subject evidence of effectiveness. Future research should employ randomized controlled trials with larger and more diverse samples, as well as longitudinal designs to evaluate the long-term impact of honey soy milk consumption on hematological and nutritional status among adolescents.

In summary, this study confirms that short-term administration of honey soy milk significantly increases hemoglobin levels in adolescent girls with menstrual anemia through improved erythropoiesis and iron absorption. These findings contribute both theoretically to the understanding of nutrient synergy in hematopoiesis and practically to the development of sustainable, food-based approaches for adolescent anemia prevention within school and community health programs.

**Implications and limitations**

The findings of this study have meaningful implications for both nutritional science and public health research. Conceptually, the results support the nutritional synergy model, demonstrating that the combined effects of macronutrients (soy protein) and micronutrients (vitamin C, iron, polyphenols) can optimize erythropoiesis and improve hemoglobin levels. This reinforces existing theories on the importance of co-factors in non-heme iron absorption and highlights the potential of functional foods in addressing micronutrient deficiencies. For future research, these findings encourage the exploration of food-based interventions using locally available ingredients, as well as studies investigating the long-term effects of dietary strategies on adolescent hematological health. From a policy perspective, the study underscores the potential role of culturally acceptable, cost-effective nutritional interventions in anemia prevention programs targeting adolescent populations.

However, the study has several limitations. The small sample size (n = 25) and purposive sampling method limit the generalizability of the results to broader populations. Additionally, the absence of a control group restricts the ability to make strong causal inferences, although the pretest–posttest design provided within-subject evidence of effectiveness. Future studies should utilize larger, more diverse samples and randomized controlled designs to confirm the efficacy of honey soy milk and evaluate its long-term impact on adolescent nutritional and hematological outcomes.

## Relevance to Practice

The findings of this study provide clear and actionable guidance for nursing practice, school health services, and community-based healthcare programs. Nurses, midwives, and community health workers can incorporate honey soy milk as a complementary, food-based intervention for adolescent girls experiencing menstrual anemia, particularly in school dormitories and community health settings. This intervention can be implemented during menstruation as part of routine adolescent health monitoring, alongside hemoglobin screening and nutrition education. For healthcare institutions and schools, honey soy milk offers a practical, affordable, and culturally acceptable strategy to support anemia prevention programs, especially in resource-limited settings where adherence to iron supplementation is low. Policymakers and program planners may also consider integrating functional food interventions such as honey soy milk into existing adolescent nutrition and reproductive health initiatives to strengthen anemia control efforts and improve adolescent well-being and academic performance.

## Conclusion

This study demonstrates that the administration of honey soy milk during menstruation is effective in increasing hemoglobin levels among adolescent girls with menstrual anemia. A statistically significant improvement in mean hemoglobin concentration was observed after five consecutive days of intervention, indicating that the combination of soy milk and honey can support erythropoiesis and improve hematological status. These findings suggest that honey soy milk may serve as a practical, affordable, and culturally acceptable non-pharmacological intervention for anemia prevention and management in adolescents. Although the study was limited by its small sample size and the absence of a control group, the results provide preliminary evidence supporting the potential role of functional food–based strategies in adolescent nutrition programs. Further studies employing randomized controlled designs and larger samples are recommended to confirm these findings and evaluate long-term effects.

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## CrediT Authorship Contributions Statement

**Yuniza:** Conceptualization, Methodology, Investigation, Writing – Original Draft, Supervision.

**Marwan Riki Ginanjar**: Data Curation, Formal Analysis, Validation, Writing – Review & Editing.

**Mar'atun Ulaa**: Resources, Project Administration, Investigation, Visualization.

**Brett Williams**: Writing – Review & Editing, Visualization, Funding Acquisition, Supervision.

## Conflicts of Interest

The authors declare that there is no conflict of interest related to this research.

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**Supplementary Materials**

Supplementary File S1: Research Instrument contains the full questionnaire used for data collection.

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