



Adaptation of Moringa Leaf Extract on Hemoglobin and Arm Circumference in Adolescent Girls Semarang

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ABSTRACT

Adolescent malnutrition, particularly anemia, remains a major public health challenge in developing countries, including Indonesia, as it increases the risk of growth retardation, developmental disorders, poor pregnancy outcomes, and infectious diseases. Nutritional interventions during adolescence are crucial for improving health and breaking the intergenerational cycle of malnutrition. This study aimed to analyze the effect of Moringa oleifera capsules on hemoglobin (Hb) levels and Mid-Upper Arm Circumference (MUAC) among adolescent girls in Semarang. A quasi-experimental study with a pretest-posttest control group design was conducted in two junior high schools in Semarang (SMPN 39 and SMPN 8), involving 102 female students aged 13–15 years, who were selected using purposive sampling. Participants were assigned to an intervention group (n = 51) receiving 300 mg of Moringa oleifera capsules twice weekly for 6 months under teacher supervision, and a control group (n = 51) receiving no supplementation. Data were collected at baseline and after the intervention, including Hb measurement (Hemocue analyzer) and MUAC. Data were analyzed using paired t-tests and independent t-tests. Results showed a significant improvement in Hb levels in the intervention group (mean pretest 11.58±0.87 g/dL; posttest 13.65±0.89 g/dL; p<0.001), whereas no significant change was found in the control group (p = 0.132). MUAC also increased significantly in the intervention group (pretest 25.50±4.06 cm; posttest 26.21±4.94 cm; p = 0.002), with a greater improvement compared to the control group (p = 0.002). In conclusion, supplementation with Moringa oleifera effectively improved Hb levels and MUAC among adolescent girls. This intervention has potential as a practical and affordable strategy for preventing anemia and improving nutritional status in adolescents.

INTRODUCTION

Adolescent malnutrition is a serious public health problem in developing countries, including Indonesia, which causes many unfavourable long-term consequences.¹ Malnutrition is defined as malnutrition (thin, dwarf, underweight) related to micronutrients (lack of essential vitamins and minerals), as well as overweight, obesity, Anemia, and diet-related infectious diseases.² Research has indicated that enhancing the nutrition and diet of teenage girls can elevate their ambitions and growth. Focusing on adolescent well-being can lead to three significant advantages for today's youth, their future, and the generations to come by providing social, economic, and demographic gains.^{3,4}

Anemia and malnutrition in adolescence can lead to stunted growth, developmental disorders, and an increased risk of infectious diseases.^{5,6} Malnutrition is also associated with lower levels of education and income status among adults.⁷ When adolescent girls are pregnant, a low Body Mass Index (BMI) can increase the risk of poor pregnancy outcomes, including stillbirth, premature birth, short gestational age, and low birth weight.⁸ Young women have a ten times greater risk of developing anemia compared to young men.^{9,10} This is due to menstruation experienced by adolescent girls every month, which results in a decrease in red blood cells in the body.¹⁰

The World Health Organization (WHO) states that globally, the occurrence of anemia among adolescents between the ages of 10 and 19 is between 44% and 88%.¹¹ The prevalence of anemia in adolescent girls in Southeast Asia is >25%, and in some Southeast Asian countries it reaches 50%.² Based on data from the 2023 Indonesian Health Survey/*Survei Kesehatan Indonesia (SKI)*, the prevalence of anemia in Indonesia in the population aged ≥ 10 years reaches 9.1%.¹² According to the Semarang City Health Office, the cases of pregnant women with SEZ (Chronic Energy Deficiency) in Semarang City in 2021 were 10.43%, and the cases of pregnant women with anemia were 15.4%.¹³ Anemia that is not treated immediately in adolescent girls can have an impact during pregnancy, so that it can cause low birth weight and stunting in children.¹⁴ Initiatives aimed at addressing anemia in teenage girls should prioritize a well-rounded diet to enhance

hemoglobin levels and the measurement of upper arm circumference. In addition, efforts to treat anemia in adolescent girls can also be done with food fortification.

Moringa Oleifera grows in tropical and subtropical regions worldwide.¹⁵ The local community consumes Moringa as a daily vegetable and has the potential to serve as a therapeutic and dietary supplement to overcome nutritional deficiencies.¹⁶ Moringa contains micronutrients essential for pregnant women, including vitamin C, vitamin A, calcium, potassium, protein, iron, sodium, and essential amino acids.¹⁷ The use of Moringa Oleifera to increase HB and Upper Arm Circumference becomes more practical and formulated with other food ingredients commonly used in the Supplementary Food Plan (RPP) by referring to the standard procedures of the Ministry of Health in 2010. This study aims to determine the effect of giving moringa leaf biscuits on the increase of Hb and Upper Arm Circumference in adolescent girls at SMPN Semarang City.

MATERIAL AND METHOD

This study employed a quasi-experimental design with a pretest-posttest control group. The research was conducted at two junior high schools in Semarang City (SMPN 39 and SMPN 8) with a total of 102 female students aged 13–15 years selected through purposive sampling. Participants were allocated into an intervention group (n = 51), which received Moringa oleifera capsules, and a control group (n = 51), which received no supplementation but continued their usual school and dietary routines.

The inclusion criteria were: (a) students who were not menstruating at the time of data collection, (b) not taking vitamins or other supplements, and (c) willing to participate. Exclusion criteria included having chronic illnesses that may affect Hb levels (e.g., kidney failure, spleen disorders, or cancer).

The intervention consisted of 300 mg Moringa oleifera extract capsules, consumed twice weekly (every Tuesday and Friday) for 6 months under teacher supervision. The extract was derived from dried Moringa leaves through a standardized process to preserve nutrient content. The control group did not receive any supplementation and continued with their usual diet and school activities. The dosage was

determined based on safety and efficacy considerations from previous studies, which demonstrated that *Moringa oleifera* supplementation in various forms (capsules, biscuits, and fortified foods) effectively increased hemoglobin levels among adolescent girls with anemia.¹⁸⁻²⁰

Data collection was conducted at baseline and after 6 months, including measurement of Hemoglobin (Hb) using Hemocue analyzers, Mid-Upper Arm Circumference (MUAC), weight, height, dietary intake (24-hour food recall), and physical activity (recall questionnaire). All measurement instruments (scales, stadiometers, hemocue) were calibrated before use to ensure data accuracy.

This study received ethical approval from the Health Research Ethics Committee at the Faculty of Medicine, Universitas Islam Sultan Agung Semarang, under the approval number No. 250/VII/2024/Komisi Bioetik.

RESULTS

Respondent characteristics: The intervention group and the control group shared similar characteristics, consisting of junior high school students in Semarang City aged 13 to 15 years and enrolled in grades VII to IX. Data collection was carried out 2 times, namely initial data collection (pretest) and final data collection (post-test).

Hemoglobin (Hb) Levels

The data categorization was based on the total Hb levels present in the blood. According to the Ministry of Health, a person can be said to be

anaemic if the haemoglobin level in the body is <12 g/dl, and it is said to be non-anemic or normal if the Hb level is ≥ 12 g/dL.²¹ In this study, it was observed that the intervention group experienced a decrease in anemia, while the control group showed an increase in anemia. This is indeed possible because the control group received no intervention (Table 1).

Based on the Kolmogorov-Smirnov normality test, it was determined that the pretest and post-test data on Hb levels in both groups exhibited a normal distribution (p -value > 0.05). So, to analyse the difference in pretest and post-test data in each group using the Paired Simple T-test.

After differential test analysis, the intervention group showed a p -value of 0.000 (<0.05). This showed that in the intervention group, there was a significant difference in Hb levels between the pretest and post-test. Meanwhile, in the control group, the p -value was 0.132 (>0.05), indicating that there was no difference in Hb levels between the pretest and post-test (Table 2).

This study utilized post-test data from both groups to determine if there was a difference between the group that received the intervention and the group that did not. Hb post-test data in both groups were normally distributed. The analysis results showed a p -value of 0.001, indicating that the intervention had a significant impact on the Hb data in the intervention group compared to the control group (Table 3).

Table 1. Distribution of Hb Levels Pretest and Post-test in The Intervention Group and Control Group

Hb Level	Pretest		Post-test	
	n = 51	%	n = 51	%
Intervention Group				
Anemia	8	15.6	6	11.7
Normal	43	84.4	45	88.3
Control Group				
Anemia	12	23.5	14	27.4
Normal	39	76.6	37	72.6

Source: Primary Data, 2024

Table 2. Analysis of Differences in Hb Levels Pretest and Post-test in The Intervention Group and Control Group

Hb	Mean/SD	p-value (Paired Simple T-test)
Intervention Group		
Pretest	11.58/0.87	0.000
Post-test	13.65/0.89	
Control Group		
Pretest	12.51/1.31	0.132
Post-test	12.23/1.59	

Source: Primary Data, 2024

Table 3. Analysis of Differences in Hb Levels of The Intervention Group and Control Group

Hb	Mean/SD	p-value (Independent T-test)
Intervention Group Post-test	13.65/0.89	0.001
Control Group Post-test	12.23/1.59	

Source: Primary Data, 2024

Upper Arm Circumference or *Lingkar Lengan Atas (LILA)*

Data categorization is based on the size of the LILA at the time of measurement. According to the Ministry of Health, a person can be said to be a Chronic Energy Deficiency (CED) if the upper arm circumference of the woman's average is <22cm. In this study, both the intervention and control groups experienced an increase in upper arm circumference in adolescent girls. It is possible that increasing the circumference of the upper arm may take a relatively longer time (Table 4).

Based on the Kolmogorov-Smirnov normality test, it was determined that the pretest and post-

test data for Upper Arm Circumference/LILA in both groups exhibited a normal distribution (p-value > 0.05). So, to analyse the difference in pretest and post-test data in each group using the Paired Simple T-test. After a differential test analysis, the intervention group showed a p-value of 0.002 (<0.05). This indicates that in the intervention group, there is a difference in LILA between the pretest and post-test. Meanwhile, the control group also experienced a difference, although not as significant as the intervention group; the p-value was 0.000 (Table 5).

This study utilized post-test data from both groups to determine if there was a difference between the group that received the intervention and the group that did not. The data on the upper arm circumference of the post-test in both groups were normally distributed. The analysis results showed a p-value of 0.002, indicating that the intervention had a significant impact on the upper arm circumference data in both the intervention and control groups (Table 6).

Table 4. Distribution of Upper Arm Circumference Frequency Pretest and Post-test in the Intervention Group and Control Group

Upper Arm Circumference (LILA)	Pretest		Post-test	
	n = 51	%	n = 51	%
Intervention Group				
Normal	43	84.3	45	88.3
Chronic Energy Deficiency (CED)	8	15.7	6	11.7
Control Group				
Normal	40	78.4	42	82.3
Chronic Energy Deficiency (CED)	11	21.6	9	17.7

Source: Primary Data, 2024

Table 5. Analysis of Differences in Upper Arm Circumference Pretest and Post-test in the Intervention Group and Control Group

Upper Arm Circumferenc (LILA)	Mean/SD	p-value (Paired Simple T-test)
Intervention Group		
Pretest	25.50/4.06	0.002
Post-test	26.21/4.94	
Control Group		
Pretest	24.02/3.47	0.000
Post-test	24.70/3.42	

Source: Primary Data, 2024

Table 6. Analysis of Differences in Upper Arm Circumference Between The Intervention Group and Control Group

Upper Arm Circumferenc (LILA)	Mean/SD	p-value (Independent T-test)
Intervention Group Post-test	26.21/4.94	0.002
Control Group Post-test	24.70/3.42	

Source: Primary Data, 2024

DISCUSSION

There is a Difference Between The Hemoglobin (Hb) Levels Between The Intervention Group and The Control Group

This study demonstrated a significant difference in hemoglobin (Hb) levels between the pre-test and post-test within the intervention group, with a p-value of 0.000 (<0.05). When comparing Hb levels between the intervention and control groups, a statistically significant difference was also observed ($p = 0.014$). These findings are consistent with those of Astuti et al., who reported a significant increase in Hb levels following the administration of moringa leaf extract.²² The study also showed that moringa leaves were effective in increasing haemoglobin levels in adolescent girls.²³ Furthermore, this study aligns with the findings of Khofifah et al., which demonstrated a significant difference in Hb levels before and after the consumption of moringa leaf extract. Moringa leaves are rich in iron, which plays a major role in hemoglobin, and vitamin C, which increases the absorption of non-heme iron by converting ferric iron (Fe^{3+}) into ferrous iron (Fe^{2+}), which is more easily absorbed.²⁴ The essential amino acid content also supports the erythropoiesis process, while bioactive compounds such as flavonoids, polyphenols, and beta-carotene, which are antioxidants, protect red blood cells from damage caused by oxidative stress.²⁴ Important minerals such as zinc, copper, and calcium also play a role in enzymatic processes that support red blood cell formation and metabolism, so that overall, moringa contributes to increased hemoglobin.²⁵

Differences Between Upper Arm Circumference/ *Lingkar Lengan Atas (LILA)* Between The Intervention Group and The Control Group

This study revealed a significant difference between the LILA scores in the pretest and post-test in the intervention group, with a p-value of 0.002 (<0.05), and in the control group, with a p-value of 0.000 (<0.05). This study is in line with the research conducted by Kasim et al. which showed that there was a significant difference between the measurement of upper circumference before and after the intervention, and moringa leaf biscuit could increase upper arm circumference, weight and protein intake in pregnant women with a chronic lack of energy in Bontoramba Municipality.¹³ In addition, this

study is also in line with research conducted by Frianti et al. which showed that the administration of moringa capsule, there was a significant increase in hemoglobin levels, body weight, and LILA in the intervention group compared to the control group. The increase in LILA indicates an improvement in the nutritional status of pregnant women who received moringa leaf capsule and the combination of moringa leaf capsule and iron supplementation proved to be more effective than iron supplementation alone.

Future research should focus on more recent innovations and more variables. The findings of this research can be applied to other groups, such as non-adolescent women of childbearing age, pregnant women, or children, to determine if the effect is consistent across different anemia-prone groups. Expanding the scope of research to these populations is important, as anemia is not limited to adolescents but also highly prevalent among pregnant women and young children, where the consequences can be more severe, such as increased risk of maternal mortality, low birth weight, and impaired cognitive development in children. Investigating the effectiveness of *Moringa oleifera* in these groups could provide a broader understanding of its role as a sustainable nutritional intervention.

CONCLUSION AND RECOMMENDATION

This study demonstrated that the intervention using *Moringa oleifera* capsules effectively increased blood Hemoglobin (Hb) levels and mid-upper arm circumference (LILA). This was evidenced by significant differences in Hb levels ($p = 0.001$) and MUAC ($p = 0.002$) between the intervention and control groups. In this study, the increase in Hb levels observed in the intervention group was consistent with the improvement in MUAC within the same group.

Based on the findings of this study, the use of *Moringa oleifera* capsules is recommended as a nutritional intervention to enhance hemoglobin levels and improve overall nutritional status among adolescent girls. Future studies with larger sample sizes, longer intervention durations, and additional variables are needed to validate the long-term efficacy and safety of *Moringa oleifera* supplementation. Moreover, further research involving other anemia-prone groups such as adult women, pregnant women,

and children would help determine the consistency of its effects and provide a broader understanding of its potential as a sustainable and evidence-based nutritional intervention.

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AUTHOR CONTRIBUTIONS

The first author contributed to the development of the prototype, data collection, data analysis, and drafting of the article, including background, methods, results, and discussion. The second author contributed to developing the application content, screening and processing data, and drafting the article, covering background, results, and discussion. The third author contributed to the development of the prototype, data collection, data analysis, and drafting of the article, including methods, results, and discussion. The fourth author contributed to the data processing, data analysis, and drafting of the article, including methods, results, and discussion. The fifth author contributed to data collection and analysis, while the sixth author contributed to data collection and article preparation. First author = Sri Achadi Nugraheni; Second author = Ari Yuniastuti; Third author = Suryani As'ad; Fourth author = Pingkan Fristiwi; Fifth author = Fatimah Asri Fadhilah Aulia; Sixth author = Shafa Alya Kamila.

CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

1. Paul D, Chakraborti C, Mishra P. Factors Affecting Malnutrition of Rural Adolescent

Girls: Evidences from Selected Districts of West Bengal. *Children and Youth Service Review*. 2023;152:1-14.

<https://doi.org/10.1016/j.childyouth.2023.107065>

2. WHO. Nutritional Anaemias: Tools for Effective Prevention and Control. World Health Organization; 2017:1-83. <https://www.who.int/publications/i/item/9789241513067>
3. Madjdian DS, Talsma EF, Vaandrager L, Gupta A Sen, van de Geest JMJ, Koelen M, et al. Nourishing Hope? Changes in Malnutrition and Changes in Girls' Aspirations - Evidence from the Suaahara II Adolescent Girls Panel in Nepal. *Journal of Adolescent Health*. 2022;70(4):617-624. <https://doi.org/10.1016/j.jadohealth.2021.10.029>
4. Anisa Y, Siti A, Sri H. Faktor-Faktor yang Berhubungan dengan Anemia pada Remaja Putri. *Lentera Perawat*. 2024;5(1):10-17. <https://doi.org/10.52235/lp.v5i1.276>
5. Yuan M, Tang T, Li Y, Wang X, Wang C, Zhang X, et al. Associations of Metals with Hemoglobin and Anemia in a Chinese Early Adolescent Cohort. *Ecotoxicology and Environmental Safety*. 2025;295:1-12. <https://doi.org/10.1016/j.ecoenv.2025.118122>
6. Suprapti E, Hadju V, Ibrahim E, Indriasari R, Erika KA, Balqis B. Anemia: Etiology, Pathophysiology, Impact, and Prevention: A Review. *Iranian Journal of Public Health*. 2025;54(3):509-520. <https://doi.org/10.18502/ijph.v54i3.18244>
7. Mulyana DW, Zain IM. Pengaruh Tingkat Pengetahuan, Pendidikan, Pendapatan, dan Perilaku terhadap Status Balita Gizi Buruk di Kecamatan Tegalsari dan di Kecamatan Tandes Kota Surabaya. *Jurnal Online UNESA*. 152-162. <https://share.google/Z8YHZSoM2DNlax0Sn>
8. Darling AM, Fawzi WW, Barik A, Chowdhury A, Rai RK. Double Burden of Malnutrition Among Adolescents in Rural West Bengal, India. *Nutrition*. 2020;79-80:110809.

- <https://doi.org/10.1016/j.nut.2020.110809>
9. Indriyani S, Kusharisupeni K, Adawiyah AR. Determinan Anemia pada Remaja Putri. *Jurnal Ilmu Kesehatan Masyarakat*. 2024;13(2):149–157.
<https://doi.org/10.33221/jikm.v13i02.2709>
 10. Suciyanti D, Kolopaking R, Mustafa A, Iwan S, Witjaksono F, Fahmida U. Effect of Optimized Food-Based Recommendations on Nutrient Intakes, Hemoglobin Levels, and Memory Performance of Adolescent Girls in East Java, Indonesia. *Nutrition Journal*. 2025 24;24(1):1-10.
<https://doi.org/10.1186/s12937-024-01061-w>
 11. Nurhasanah I. Penyuluhan Sebagai Upaya Peningkatan Pengetahuan Tentang Anemia pada Remaja Putri Pondok Pesantren Slafiyah Syafi'iyah Sukorejo Situbondo. *Pengabdian Masyarakat Cendekia (PMC)*. 2023. 27;2(1):23–25.
<https://doi.org/10.55426/pmc.v1i2.233>
 12. Rahman RA, Fajar NA. Analisis Faktor Risiko Kejadian Anemia pada Remaja Putri: Literatur Review. *Jurnal kesehatan Komunitas (Journal of Community Health)*. 2024.10(1):133–140.
<https://doi.org/10.25311/keskom.Vol10.Is1.1403>
 13. Kasim F, Sirajuddin S, Amiruddin R. The Effect of Moringa Oleifera Leaf Biscuit on the Increase of Body Weight and Upper Arm Circumference for Chronic Energy Deficiency among Pregnant Women in Bontoramba District Jeneponto Regency. *Indian Journal of Public Health Research and Development*. 2019;10(4):1018.
<https://doi.org/10.5958/0976-5506.2019.00842.8>
 14. Semarang City Health Office. Anemia. 2022.
 15. Gopalakrishnan L, Doriya K, Kumar DS. Moringa Oleifera: A Review on Nutritive Importance and Its Medicinal Application. *Food Science and Human Wellness*. 2016;5(2):49–56.
<https://doi.org/10.1016/j.fshw.2016.04.001>
 16. Setyaningrum, Ira Y, Wulandari I, SWP. Literature Review Penyebab dan Upaya Pecegahan Anemia pada Remaja Putri. *Journal of Noncummunicable Diseases*. 2023;3 (2):84–100.
<http://dx.doi.org/10.52365/jond.v3i2.858>
 17. Fahey J.W. Moringaoleifera: A Review of The Medical Evidence for Its Nutritional, Therapeutic, and Prophylactic Properties. *Trees Life Journal*. 2005;1(5):1-25.
<http://www.tfljournal.org/article.php/20051201124931586>
 18. Alwi J, Dahlia B, Ibrahim MS, Fandir A, Anwar R, Hurfiati. Comparative of Moringa (Moringa oleifera) Cookies and Capsules on Hemoglobin Levels in Adolescent Girls with Iron Deficiency Anemia. *Media Gizi Kesmas*. 2025;14(1):87–93.
<https://doi.org/10.20473/mgk.v14i1.2025.87-93>
 19. Khanam M, Sanin KI, Ara G, Sultana RR, Boitchi AB, Farzana FD, et al. Effects of Moringa Oleifera Leaves on Hemoglobin and Serum Retinol Levels and Underweight Status Among Adolescent Girls in Rural Bangladesh. *Frontiers Nutrition*. 2022; 9:959890.
<https://doi.org/10.3389/fnut.2022.959890>
 20. Khofifah N, Mardiana. The Moringa Leaf (Moringa Oleifera) Biscuits Have an Effect on Hemoglobin Levels in Anemic Adolscent Girls. *AcTion: Aceh Nutrition Journal*. 2023;8(1):43–50.
<http://dx.doi.org/10.30867/action.v8i1.614>
 21. Sholicha CA, Muniroh L. Hubungan Asupan Zat Besi, Protein, Vitamin C dan Pola Menstruasi Dengan Kadar Hemoglobin Pada Remaja Putri Di SMAN 1 Manyar Gresik. *Media Gizi Indonesia*. 2019;14(2):147-153.
<https://doi.org/10.204736/mgi.v14i2.147-153>
 22. Astuti AB, Mulyanti S, Diyono. The Effectiveness of the Interprofessional Collaboration (IPC) Program on The Attitude of Mothers and Health Cadres on Stunting at Puskesmas Karanganom Klaten Central Java Republic of Indonesia.

Electronic Journal of General Medicine. 2021;18(6):1-5.

<https://doi.org/10.29333/ejgm/11315>

23. Koul B, Chase N. Moringa Oleifera Lam.: Panacea to Several Maladies. *Journal of Chemical and Pharmaceutical Research*. 2015;7(6):687-707.
24. Sokhela H, Govender L, Siwela M. Complementary Feeding Practices and Childhood Malnutrition in South Africa: The Potential of Moringa Oleifera Leaf Powder

as a Fortificant: A Narrative Review. *Nutrients*. 2023;15(8):1-17.

<https://doi.org/10.3390/nu15082011>

25. Mauliku N, Darmawan FH, Yuliana H, Murtiani F, Norma N. The Effect of Moringa (*Moringa Oleifera* L.) Leaf Extract Capsules in Increasing Hemoglobin Levels in Adolescent Girls. *Indonesian Journal of Global Health Research*. 2024;7(1):303-310. <https://doi.org/10.37287/ijghr.v7i1.4293>