

The Prevalence of Anemia and Correlation with Body Mass Index in Private Junior High School Adolescents, Sunter, North Jakarta

Hartiyowidi Yuliawuri^{1*}, Aplina Krismutia Simarmata¹, Giving Love Paskah Anjanis Dohude¹, Jelia Carolina Talahatu¹, Lieprilson Firdaus¹, Jeffrey Wibowo²

¹Department of Biology, Calvin Institute of Technology, Calvin Tower, Industri Raya Blok B14, Kemayoran, Jakarta 10610, Indonesia

²Department of Health Services, Calvin Institute of Technology, Calvin Tower, Industri Raya Blok B14, Kemayoran, Jakarta 10610, Indonesia

Article Information

Article history

Received: June 25, 2025

Revised: November 28, 2025

Accepted: November 30, 2025

Keywords: Anemia; BMI; Iron Deficiency; Teenager

Abstract

Iron-deficiency anemia (IDA) needs special attention following the WHO framework to reduce the anemia cases. Based on the Indonesian Health Survey data in 2023, the prevalence of anemia in children and teenagers (5-14 years old) in Indonesia was 16.3%. This study aimed to determine the prevalence of iron deficiency anemia and the correlation between anemia and Body Mass Index (BMI). We screened using the hemoglobin measurement and BMI calculation from adolescents in a private Junior High School in Sunter, North Jakarta. We found that the anemia prevalence, 21.2% (18 out of 85 participants), was mild anemia. The correlations of anemia and BMI analysis were not statistically significant. The implication of this community service can raise awareness of iron-deficiency anemia, according to the educational session's outcome.

*Corresponding Author

© 2025 Some rights reserved

Hartiyowidi Yuliawuri

E-mail: hartiyowidi.yuliawuri@calvin.ac.id

INTRODUCTION

Hemoglobin (Hb) is a globular protein in red blood cells and has the role to bind and deliver oxygen from the lungs throughout the body. Anemia is a condition in which the body lacks hemoglobin, which is seen during Hb testing. The Hb concentration in blood is less than 12 g/dL in females and less than 13 g/dL in males (Izzara et al., 2023). The hemoglobin deficiency causes reduced oxygen distribution to body tissues and organs. In developing countries, the nutritional challenges among populations remain a critical public health problem that requires sustained attention and evidence-based interventions. There were many factors causing anemia, and one of them is micronutrient deficiency (Fathony et al., 2022). In Indonesia, anemia is a common disease. One in five Indonesian is at risk of anemia in various age ranges. The issue of anemia is not limited to adults, but adolescents in critical periods of growth and development are also highly vulnerable to this condition. The prevalence of anemia in adolescents is 32% which means that three out of ten adolescents suffer from anemia (Badan Penelitian dan Pengembangan Kesehatan, 2019).

Adolescents represent a population group particularly vulnerable to iron deficiency anemia. This type of anemia is influenced by several contributing factors, including hormonal fluctuations, high levels of physical activity, and inadequate intake of balanced and nutritious food (Puspitasari et al., 2022). Both male and female adolescents are at risk of anemia. In Indonesia, the prevalence of anemia among females is reported 6% higher than among males (Kementerian Kesehatan Republik Indonesia, 2021). Consequently, early preventive interventions are needed to reduce the risk of long-term health complications associated with iron deficiency anemia.

This community service activity involves a screening of hemoglobin concentration and counseling on iron deficiency anemia and its prevention in adolescents. Direct examination is carried out to determine hemoglobin concentration as an indicator of anemia. This study aims to assess the hemoglobin concentration as an early detection of anemia to improve awareness of iron-deficiency anemia. In addition, the correlation between anemia and Body Mass Index (BMI) can be obtained.

Through this study, it is expected that participants will gain awareness of their hemoglobin concentration and its correlation with anemia, understand the health risks associated with iron deficiency anemia, and adopt preventive measures.

MATERIALS AND METHODS

Materials

The materials used in this community service were measuring instruments to obtain Body Mass Index (BMI) data and hemoglobin concentrations. The BMI data were calculated to assess the relationship between body weight and the prevalence of anemia. The height of respondents was measured using a stadiometer, and weight was measured using a digital scale. The BMI was calculated by dividing body weight (kilograms) by height (square meters). Hemoglobin concentration was measured using a hemoglobin meter (APEXBIO HemoSmart Gold meter) with capillary blood samples. The community service team consisted of personnel trained in capillary puncture techniques, and all hemoglobin measurements were performed by certified healthcare professionals (physicians). The Hemoglobin meter provided quantitative results indicating the hemoglobin concentration within red blood cells in g/dL (Enggardany et al., 2021).

Methods

This study used a cross-sectional design to obtain the hemoglobin concentration and analyze the prevalence of anemia, with or without symptoms. We propose the community service to the school headmaster and explain the study and its outcome. The community service was conducted on May 31st, 2024, involving 85 adolescent participants from a private Junior High School in the Sunter area, North Jakarta (Fig. 1).

We do the pre-engagement to participant respondents like our study introduction, the aim of community services, and the presentation of our material. The participants were instructed to complete a registration questionnaire to obtain baseline data on age, gender, and the presence of anemia symptoms. The categories that we used to collect the presence of anemia symptoms were weakness, tiredness, fatigued, exhausted, and neglectful over the past two weeks. If the participants exhibited at least one symptom, they were considered to have clinical indications consistent with anemia. All respondents took part voluntarily and provided verbal consent after receiving a clear explanation of the purpose of the screening and hemoglobin testing during the educational session. Furthermore, the participants were invited to complete an online quiz following the session, which served as an evaluation tool to assess their understanding of the material presented (Fig. 2).



Fig. 1. Community service implementation

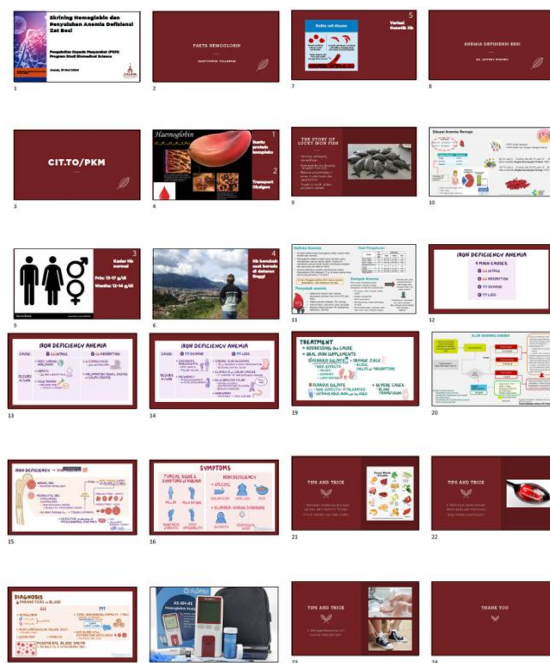


Fig. 2. Community service presentation material

The other variables investigated in this service were hemoglobin concentration and Body Mass Index (BMI). The BMI data of respondents was checked by students and healthcare professionals (physicians) to test the hemoglobin concentration (Fig. 3). The prevalence of anemia is defined as a hemoglobin concentration of <13 g/dL for males and <12 g/dL for females. Meanwhile, Body Mass Index (BMI) is described as a parameter to determine an individual's weight status, whether classified as underweight, normal, or overweight.

The school's teachers and staff support these community service activities. Furthermore, the results

of this study will initiate the community partner (school) to raise awareness of iron-deficiency anemia cases in student participants. The data obtained from respondents stratified by age, gender, and the presence or absence of anemia symptoms to analyze the prevalence of anemia among adolescents. The correlation between anemia prevalence and Body Mass Index (BMI) was analyzed using SPSS software version 29.0.2.0. Data normality assessed by the Kolmogorov-Smirnov test. Categorical variables were numerically coded or presented as percentages. The prevalence of anemia was estimated using the Clopper-Pearson method with a 95% confidence interval (CI).



Fig. 3. The measurement of hemoglobin level used the Hb-meter

RESULTS AND DISCUSSION

An online quiz was administered following the educational session on anemia to evaluate participants' understanding, with a specific focus on iron deficiency anemia (IDA). The results showed that approximately 68% of the participants answered correctly. These educational sessions contributed to improving students' knowledge of anemia and increasing their awareness of its symptoms.

Table 1. Descriptive statistical analysis of participants

Respondent, N=85				
Group	n	Ages, mean (SD) (Year)	Hb, mean (SD) (g/dL)	BMI, mean (SD)
Male	53	13.17 (0.87)	13.82 (1.43)	21.07 (4.39)
Female	32	13.31 (0.64)	14.04 (1.06)	20.95 (5.47)

Hb, hemoglobin; BMI, body mass index; N, total of respondents; n, total of respondents per group; SD, standard deviation.

The participants involved in this study range from 12 to 15 years, with 53 males (62%) and 32 females (38%). The data in this study showed that the average age obtained was 13.17 years and 13.31 years in the

male and female groups, respectively. The average Hemoglobin concentration in this study was 13.9 g/dL, with the lowest being 10.1 g/dL and the highest being 16.6 g/dL. The average Hemoglobin concentration for males was 13.82 g/dL, with the lowest being 10.1 g/dL and the highest being 16.6 g/dL. The average Hemoglobin level for females was 14.04 g/dL, with the lowest level being 11.6 g/dL and the highest level being 16.1 g/dL (Table 1).

Prevalence of Anemia

Based on hemoglobin level results from 85 respondents (Table 2), the prevalence of anemia was higher in males (32.1%, 95% CI: 19.9–46.3%) than in females (3.1%, 95% CI: 0.1–16.2%) (Fig. 4). Otherwise, some study generally reports a higher prevalence of anemia among female adolescents than males (Rai et al., 2023; Nunes et al., 2020; Wratsangka et al., 2024). The findings of this study may reflect demographic characteristics and sample distribution, because the male respondents outnumbered females, potentially influencing the observed prevalence rates. These findings align with other studies that have also reported a higher anemia prevalence among males (22.5%) compared to females (19.7%) (Zelege et al., 2020).

Table 2. Distribution of anemia by gender

Gender	Anemia	Normal	Total
Men	17	36	53
Women	1	31	32
Total	18	67	85

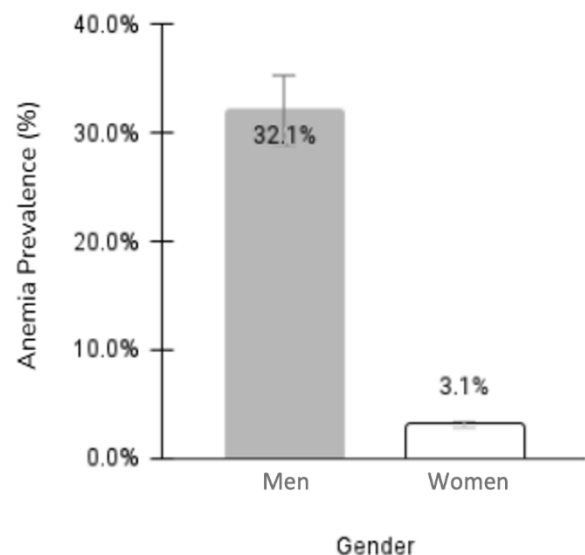


Fig. 4. Prevalence of anemia in men (grey, n = 53) and women (white, n = 32)

In addition, all respondents with anemia in this study were categorized as mild anemia with the Hb

concentration above 10 g/dL. A lack of hemoglobin concentration indicates mild anemia and may result from dietary changes, medication use, or underlying medical conditions. Other studies have reported that mild anemia constitutes a significant proportion of anemia cases identified in sampled populations (Weckmann et al., 2023). Management through iron supplementation or dietary improvement is essential to prevent the progression of mild anemia into chronic anemia, which can adversely affect children's growth and development (Labib et al., 2018).

Hemoglobin concentrations were also influenced by uncontrollable factors, such as age, gender, and iron metabolism in the body. During adolescence, significant physical, biological, and psychological changes occur. If daily iron requirements were not met during this critical developmental period, it may lead to physiological impairments, including reduced red blood cell production and organ dysfunction (Jacobus et al., 2016; Kumar et al., 2022).

The Presence of Symptoms of Anemia

This study showed a high prevalence of anemia symptoms in respondents without anemia (32.8%, 95% CI 21.8-45.4%) compared to respondents with anemia (11.1%, 95% CI 1.4-34.7%) (Fig. 5). This finding is likely attributable to the timing of hemoglobin sampling, which was conducted on the last day of the final semester examination. Some students reported experiencing the symptoms associated with anemia, despite having hemoglobin levels within the normal range (without anemia). The variability in hemoglobin concentration observed in this study may be influenced by the diverse physiological demands of adolescents, including factors such as gender, age, dietary intake, lifestyle, and geographical location (Barrera-Reyes & Tejero, 2019; Jacobus et al., 2016).

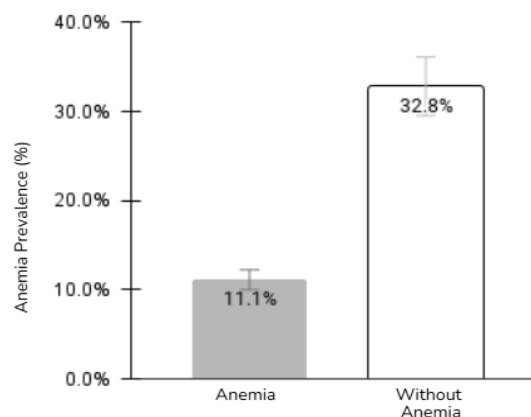


Fig. 5. Prevalence of anemia symptoms among respondents with anemia (grey, n = 18) and without anemia (white, n = 67)

We found the prevalence of anemia without symptoms was 3 times higher (26.2%, 95% CI 15.8-39.1%) compared to cases of anemia with symptoms (8.3%, 95% CI 1.0-27.0%) (Fig. 6). This phenomenon suggests that individuals may still be at risk for iron deficiency anemia even in the absence of clinical symptoms. The onset of anaemia-related symptoms is moderated by individual variations in physical fitness and general health status (Weckmann et al., 2023; Wratsangka et al., 2024). Therefore, the counseling provided in this study aims to raise awareness about the importance of routine hemoglobin concentration screening as a preventive measure to reduce the incidence of iron deficiency anemia.

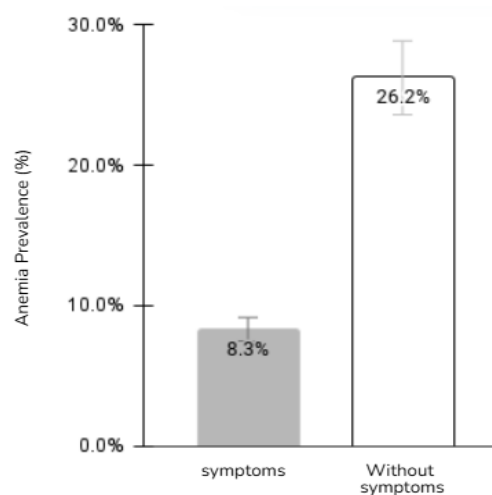


Fig. 6. Prevalence of anemia among respondents with symptoms (grey, n = 24) and without symptoms (white, n = 61)

Correlation Between Anemia Prevalence and Body Mass Index (BMI)

The Body Mass Index (BMI) of male and female adolescent students falls within the normal range. Based on the correlation data of anemia prevalence and BMI using the Pearson correlation test, the Pearson correlation results (r) were -0.108, and the 2-tailed significance value (p) was 0.324 (Table 3). Based on Pearson's analysis, the correlation coefficient (r) value measures the strength of the correlation in the range of -1 to 1, where zero (0) indicates that two variables does not correlate, one (1) indicates that two variables have a positive linear correlation, and -1 indicates that two variables have a negative linear correlation. The r value from the study shows a negative correlation direction. When one variable increases, the other variable tends to decrease. However, the 2-tailed significance value (p) from this study is above the significance of p = 0.05, indicating that the correlation obtained is not statistically significant. The negative linear correlation

can be caused by chance, so it should not be concluded that the lower the BMI, the higher the risk of anemia.

Table 3. Correlation between anemia prevalence and Body Mass Index (BMI)

		Anemia Prevalence	BMI
Anemia Prevalence	Pearson Correlation	1	-0.108
	Sig. (2-tailed)		0.324
	N	85	85
BMI	Pearson Correlation	-0.108	1
	Sig. (2-tailed)	0.324	
	N	102	102

The study by Enggardany et al. (2021) demonstrated a correlation between anemia and Body Mass Index (BMI), indicating that underweight adolescent females had a 1.198-fold higher risk of developing anemia compared to those with normal BMI. Conversely, another study found that females with an overweight BMI exhibited a lower risk of anemia. However, there was no significant association between BMI and anemia observed in the toddler population (Kamruzzaman, 2021).

These service activities involved collaboration between lecturers, students, and physicians from the Biology Program Study, Calvin Institute of Technology. The primary contribution of this activity was to enhance understanding of anemia, as evidenced by quiz scores administered after the presentation. Additionally, the activity had a positive impact on raising awareness about anemia, particularly iron deficiency anemia, within the school community (Table 4).

Table 4. Changes resulting from community service

Initial Condition	Intervention	Condition Change
The awareness about anemia is still low among students.	Students checked for Body Mass Index (BMI), Hemoglobin concentration, and taking an iron supplement.	There were 68% of students answered the quiz correctly. There are no significant symptoms of anemia after the intervention using the iron supplement.

CONCLUSION

An initial survey was conducted to collect baseline data from participants, followed by an

educational session on anemia. Subsequently, hemoglobin concentrations and Body Mass Index (BMI) were screened as part of this community service activity. Our study identified an anemia prevalence of 21.2%, with a higher proportion of anemia cases observed in male than in female. Although most of anemia cases categorized as mild anemia, iron supplementation may be needed when clinical indications and symptoms are present. Notably, a considerable proportion of anemia cases in our study were asymptomatic, highlighting the importance of increasing awareness about the risk of undetected anemia in both male and female adolescents.

Regular screening of hemoglobin concentration, together with symptom recognition, were needed to prevent the anemia cases in adolescents. These community services can raise the knowledge of students and monitor the anemia prevalence. Furthermore, the collaboration to school-based iron-supplement programs and community service activities should incorporate more comprehensive testing, such as measuring ferritin concentrations, to more accurately classify iron deficiency. This activity contributes to early prevention, particularly among high-risk adolescent populations.

ACKNOWLEDGEMENTS

The authors of community services would like to thank the Calvin Institute of Technology for the funding support with grant number (LPPM-M-DR-2023-03-04-001). We would also like to thank the parties who helped assisted in carrying out the community services at a private junior high school in the Sunter area, North Jakarta.

REFERENCES

- Badan Penelitian dan Pengembangan Kesehatan. (2019). *Laporan Nasional Riset Kesehatan Dasar 2018*. Jakarta: Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan (LPB). <https://repository.badankebijakan.kemkes.go.id/id/eprint/3514/>
- Barrera-Reyes, P. K., & Tejero, M. E. (2019). Genetic variation influencing hemoglobin levels and risk for anemia across populations. *Annals of the New York Academy of Sciences*, 1450(1), 32-46. <https://doi.org/10.1111/nyas.14200>
- Enggardany, R., Hendrati, L. Y., & Hairi, N.N. (2021). Relationship between Body Mass Index (BMI) and Anemia Among Adolescent Indonesian Girls (Analysis of The Indonesia Family Life Survey 5th Data). *Amerta Nutrition*, 5(4), 347. <https://doi.org/10.20473/amnt.v5i4.2021.347-352>
- Fathony, Z., Amalia, R., & Lestari, P.P. (2022). Anemia Prevention Education in Adolescents and The Right Way To Consume Tablets for Adding Blood. *Jurnal Pengabdian Masyarakat Kebidanan*, 4(2), 49-53. <https://doi.org/10.26714/jpmk.v4i2.9967>

- Izzara, W. A., Yulastris, A., Erianti, Z., Putri, M. Y., & Yuliana. (2023). Penyebab, Pencegahan dan Penanggulangan Anemia pada Remaja Putri (Studi Literatur). *Jurnal Multidisiplin West Science*, 2(12),1051-1065. <https://doi.org/10.58812/jmws.v2i12.817>
- Jacobus, M. C., Mantik, M. F. J., & Umbah, A. (2016). Perbedaan Kadar Hemoglobin Pada Remaja Gizi Baik yang Tinggal di Pegunungan dengan yang tinggal di Tepi Pantai. *Jurnal e-Clinic*, 4(1),1-6. <https://doi.org/10.35790/ecl.v4i1.11696>
- Kamruzzaman, Md. (2021). Is BMI Associated With Anemia and Hemoglobin Level of Women and Children in Bangladesh: A Study With Multiple Statistical Approaches. *PLOS ONE*, 16(10). <https://doi.org/10.1371/journal.pone.0259116>
- Kementerian Kesehatan Republik Indonesia. (2018). *Pedoman Pencegahan dan Penanggulangan Anemia Pada Remaja Putri dan Wanita Usia Subur (WUS)*. <https://ayosehat.kemkes.go.id/buku-pedoman-pencegahan-dan-penanggulangan-anemia-pada-remaja-putri-dan-wanita-usia-subur>
- Kumar, S.B., Arnipalli, S. R., Mehta, P., Carrau, S., & Ziouzenkova. (2022). Iron Deficiency Anemia: Efficacy and Limitations of Nutritional and Comprehensive Mitigation Strategies. *Nutrients*, 2022,14,2976. <https://doi.org/10.3390/nu14142976>
- Labib, A., G., El-Bana, S. M., Ahmed, S. M., & Abolwafa, N. F. (2018). The Effect of Chronic Anemia on Physical Growth and Development among Children Under Five Years. *Minia Scientific Nursing Journal*, 4(1),11-21. <https://doi.org/10.21608/msnj.2018.187744>
- Nunes, A. R., Mairos, J., Brillhante, D., Marques, F., Belo, A., Cortez, J., & Fonseca, C. (2020). Screening for Anemia and Iron Deficiency in the Adult Portuguese Population. *Anemia*. <https://doi.org/10.1155/2020/1048283>
- Puspitasari, H. Z. G., Armini, N. K. A., Pradanie, R., & Triharini, M. (2022). Anemia Prevention Behavior in Female Adolescents and Related Factors Based on Theory of Planned Behavior: A Cross-sectional Study. *Jurnal Ners*, 17(1),25-30. <https://doi.org/10.20473/jn.v17i1.27744>
- Rai, R. K., Shinde, S., Jan-Walter, D. N., & Fawzi, W. W. (2023). Predictors of Incidence and Remission of Anemia among Never-Married Adolescents Aged 10-19 Years: A Population-Based Prospective Longitudinal Study in India. *Current Development in Nutrition*, 7(2023),100031. <https://doi.org/10.1016/j.cdnut.2023.100031>
- Weckmann, G., Kiel, S., Chenot, J., & Angelow, A. (2023). Association of Anemia with Clinical Symptoms Commonly Attributed to Anemia-Analysis of Two Population-Based Cohorts. *Journal of Clinical Medicine*, 2023,12,921. <https://doi.org/10.3390/jcm12030921>
- Wratsangka, R., Tungka, E. X., Murthi, A. K., Ali, S., Nainggolan, I. M., & Sahiratmadja, E. (2024). Anemia Among Medical Students from Jakarta: Indonesia-Iron Deficiency or Carrier Thalassemia?. *Anemia*, 2024, 1-8. <https://doi.org/10.1155/2024/4215439>
- Zelege, M. B., Shaka, M. F., Anbesse, A. T., & Tesfaye, S. H. (2020). Anemia and Its Determinants Among Male and Female Adolescents in Southern Ethiopia: A Comparative Cross-Sectional Study. *Anemia*, 2020,1-10. <https://doi.org/10.1155/2020/3906129>