



Association Between Nutritional Status And Anemia Incidence Among High School Adolescent Girls

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ABSTRAK

Latar Belakang: Anemia merupakan masalah kesehatan global yang kritis pada remaja putri dan sering kali dikaitkan secara teoretis dengan status gizi kurang. Namun, fenomena *hidden hunger* menunjukkan bahwa defisiensi mikronutrien tidak selalu tercermin dari parameter dasar antropometri, sehingga korelasi aktual antara status gizi dan kejadian anemia memerlukan validasi empiris. **Tujuan:** Penelitian ini bertujuan untuk menganalisis hubungan antara status gizi dengan kejadian anemia pada remaja putri di SMA Negeri 20 Pangkep. **Metode:** Penelitian observasional analitik ini menggunakan desain *cross-sectional* yang dilaksanakan pada Desember 2025. Sebanyak 92 remaja putri dari kelas X-XII dipilih menggunakan teknik *total sampling*. Data dikumpulkan melalui pengukuran antropometri untuk menentukan Indeks Massa Tubuh menurut Umur (IMT/U) dan pemeriksaan kadar hemoglobin kapiler menggunakan alat POCT. Analisis data menggunakan uji *Pearson Chi-Square* dan *Prevalence Ratio* (PR) pada *Confidence Interval* (CI) 95%. **Hasil:** Temuan menunjukkan prevalensi anemia di lokasi penelitian sebesar 23,9%. Analisis statistik menunjukkan bahwa proporsi anemia pada remaja putri kategori kurus (31,3%) secara deskriptif lebih tinggi namun tidak berbeda bermakna dibandingkan mereka yang berstatus gizi normal (22,4%). Uji bivariat mengonfirmasi tidak terdapat hubungan yang signifikan secara statistik antara status gizi dengan kejadian anemia ($p = 0,449$; PR = 1,40; 95% CI: 0,60–3,23). **Kesimpulan:** Status gizi makro (IMT) bukan determinan utama kejadian anemia pada populasi ini, yang mengindikasikan bahwa remaja putri dengan massa tubuh normal memiliki risiko yang sama terhadap defisiensi besi. Oleh karena itu, distribusi Tablet Tambah Darah (TTD) harus menjangkau seluruh remaja putri secara merata, yang diiringi dengan edukasi gizi yang berkelanjutan.

ABSTRACT

Background: Anemia remains a critical global health issue among adolescent girls, often theoretically linked to an underweight nutritional status. However, the phenomenon of "hidden hunger" indicates that micronutrient deficiencies are not always reflected in basic anthropometric parameters, requiring empirical validation of the actual correlation between nutritional status and anemia incidence. **Purpose:** This study aimed to

*analyze the relationship between nutritional status and the incidence of anemia among adolescent girls at SMA Negeri 20 Pangkep. **Methods:** This observational analytic study employed a cross-sectional design, conducted in December 2025. A total of 92 adolescent girls from grades X-XII were selected using a total sampling technique. Data were collected through anthropometric measurements to determine the Body Mass Index-for-Age (BMI/A) and capillary hemoglobin testing using a POCT device. Data were analyzed using the Pearson Chi-Square test and Prevalence Ratio (PR) at a 95% Confidence Interval (CI). **Results:** The findings revealed an anemia prevalence of 23.9% in the study location. Statistical analysis showed that the proportion of anemia among underweight adolescent girls (31.3%) was descriptively higher but not significantly different from those with a normal nutritional status (22.4%). The bivariate test confirmed no statistically significant relationship between nutritional status and the incidence of anemia ($p = 0.449$; $PR = 1.40$; 95% CI: 0.60–3.23). **Conclusion:** Macro-nutritional status (BMI) is not a primary determinant of anemia in this population, implying that adolescent girls with a normal body mass share an equal risk of iron deficiency. Therefore, the uniform distribution of Weekly Iron and Folic Acid Supplementation (WIFAS/TTD) must target all adolescent girls evenly, strongly coupled with continuous nutritional education.*

INTRODUCTION

Anemia remains a major global health burden, persistently affecting women and adolescent girls, particularly in developing countries like Indonesia (Safiri et al., 2021). The World Health Organization (2024) emphasizes the urgent need for comprehensive frameworks to accelerate anemia reduction globally, as reduction targets for women of reproductive age have not yet been fully met. Similar high prevalence rates are consistently reported across other developing regions, such as the findings documented by Ghimire et al. (2024) among school-going adolescents in similar developing nations, highlighting it as a cross-continental public health crisis that requires immediate attention (Belay et al., 2025). Adolescent girls are particularly vulnerable to this condition due to drastically increased iron requirements for rapid physical growth (growth spurt) and regular monthly blood loss from the menstrual cycle (World Health Organization, 2024). At the national level, studies indicate that the prevalence of anemia in Indonesia remains alarming, affecting approximately 32% of adolescents aged 15-24 years (Sari et al., 2022).

The impact of anemia on adolescent girls is critical; it affects not only physical health, such as decreased immunity, but also cognitive function and productivity at school. Recent international studies emphasize that adolescents suffering from anemia are highly susceptible to cognitive dysfunction and exhibit significantly lower learning concentration and academic performance compared to their non-anemic peers (Yeboah et al., 2024). Furthermore, it poses long-term risks such as pregnancy complications and stunting in their future offspring (Sari et al., 2022).

One risk factor often theoretically associated with the incidence of anemia is nutritional status. In Indonesia, the nutritional status of adolescents is standardly evaluated using the Body Mass Index-for-Age (BMI/A) criteria established by the Ministry of Health of the Republic of Indonesia (Ministry of Health of the Republic of Indonesia, 2020). Previous studies have highlighted that poor nutritional status often predisposes adolescents to inadequate macro- and micronutrient intake, significantly increasing their vulnerability to iron deficiency and anemia (Sari et al., 2022). This assumption often leads adolescent health programs, such as the School Health Unit (UKS), to focus their monitoring and supplementation programs primarily on adolescent girls who appear physically thin. However, systematic reviews indicate that the effectiveness of these supplementation programs is frequently hindered by low adherence rates among adolescent girls, which remains a critical challenge regardless of their baseline nutritional status (Silitonga et al., 2023). To combat this, Weekly Iron and Folic Acid Supplementation (WIFAS) programs have been widely implemented in schools; however, recent mixed-method studies, such as those by Maheswari et al. (2024), reveal that evaluating adherence remains a complex component. Their success is heavily dependent on active school-level execution and continuous adolescent girl compliance (Khanal et al., 2024).

Consequently, several recent studies have shown inconsistencies in the relationship between nutritional status and anemia. The phenomenon of "hidden hunger" indicates that micronutrient deficiencies (such as iron) can occur in individuals with normal weight or even overweight. Beyond basic caloric intake, recent evidence reveals that dietary diversity and specific consumption habits, such as the frequent intake of iron-inhibiting beverages like tea, are strongly associated with anemia vulnerability regardless of a normal Body Mass Index (Sadiq et al., 2024). Health assessments relying solely on anthropometric (physical) examinations have the potential to cause missed diagnosis of anemia cases among adolescent girls with

normal nutritional status (Dhurde et al., 2024). Therefore, direct examination of hemoglobin levels becomes the most accurate screening method compared to physical assessment alone.

Furthermore, the high school period represents a critical window of opportunity for nutritional intervention before these adolescent girls enter the reproductive stage. Therefore, relying solely on anthropometric measurements is insufficient. Integrating accurate hemoglobin screening into school health programs (UKS) is mandatory to ensure that no adolescent girl with anemia is overlooked, regardless of their body size.

In the research location, specifically Pangkajene and Kepulauan Regency, comprehensive anemia screening involving biochemical blood tests remains limited. This situation is particularly evident in SMA Negeri 20 Pangkep, a public high school with a significant population of adolescent girls. Based on preliminary observations, the school has not yet implemented a routine program for invasive hemoglobin examination for all adolescent girls. Consequently, the actual prevalence of anemia, especially among adolescent girls with normal nutritional status, remains unknown. Based on this background, this study aims to analyze the association between nutritional status and the incidence of anemia among adolescent girls at SMA Negeri 20 Pangkep to provide empirical data for developing more targeted and inclusive school health programs.

METHODS

This study employed an observational analytic design with a cross-sectional approach to analyze the relationship between nutritional status and the incidence of anemia. The research was conducted at SMA Negeri 20 Pangkep, Pangkajene and Kepulauan Regency, South Sulawesi. The data collection period took place in December 2025. The population in this study included all adolescent girls in grades X, XI, and XII who were actively enrolled in the school, totaling 92 adolescent girls. The minimum sample size was calculated using the Lemeshow formula for a cross-sectional study with a finite population, utilizing a 95% confidence level, an estimated proportion of 50%, and a 5% margin of error ($d = 0.05$). Based on this calculation, the minimum required sample was approximately 75 respondents. However, since the total population was highly manageable and to achieve maximum accuracy by avoiding sampling error, the researchers employed a total sampling (saturation sampling) technique. Therefore, the entire population meeting the inclusion criteria—namely adolescent girls present during the study and in good health—were involved as respondents, resulting in a final sample of 92 adolescent girls. This number was considered highly sufficient as it exceeded the minimum sample adequacy requirement. Prior to data collection, all respondents received an explanation regarding the study objectives and stated their willingness to participate in this study.

Data collection was performed through anthropometric measurements and biochemical blood tests using standardized instruments. The independent variable, nutritional status, was assessed by measuring body weight using a digital stepping scale with a precision of 0.1 kg, and measuring body height using a Microtoise with a precision of 0.1 cm. Anthropometric data were then processed to determine the Body Mass Index for Age (BMI/A) z-score based on Child Anthropometry standards (Ministry of Health of the Republic of Indonesia, 2020). The dependent variable, anemia incidence, was measured based on capillary blood hemoglobin levels. Measurement was conducted using a digital Point of Care Testing (POCT) device, brand EasyTouch GCHb. Consumables used included hemoglobin strips, sterile single-use lancets, and 70% alcohol swabs for disinfection. Anemia diagnosis was established referring to

World Health Organization criteria (World Health Organization, 2024), specifically if the hemoglobin level was < 12.0 g/dL.

Data analysis was performed using the assistance of statistical software. Data analysis consisted of univariate analysis to describe respondent characteristics based on age, nutritional status category, and anemia status in the form of frequency distributions. Furthermore, bivariate analysis was conducted to examine the relationship between independent and dependent variables. To rigorously test the hypothesis, the Pearson Chi-Square (χ^2) statistical test was applied with a 95% confidence level ($\alpha = 0.05$). To assess the magnitude of the risk and epidemiological association, the Prevalence Ratio (PR) and its 95% Confidence Interval (CI) were specifically calculated and reported. A p-value of < 0.05 was considered statistically significant.

RESULTS

This study was conducted at SMA Negeri 20 Pangkep, Pangkajene and Kepulauan Regency, in December 2025. Following the screening of the enrolled adolescent girl population based on predetermined inclusion and exclusion criteria, 92 healthy respondents were obtained. All collected data from anthropometric measurements and blood hemoglobin level examinations were verified for completeness prior to statistical analysis.

To establish the baseline profile of the sample, the demographic distribution of the research subjects—encompassing key characteristics such as age and educational grade level that represent the adolescent girl population at the school—is systematically presented in Table 1.

Table 1. Distribution of General Characteristics of Respondents Based on Age and Grade (n=92)

Characteristics	Frequency (n)	Percentage (%)
Age (Years)		
15 Years	28	30.4
16 Years	37	40.2
17 Years	20	21.7
18 Years	7	7.6
Grade		
Grade X	41	44.6
Grade XI	38	41.3
Grade XII	13	14.1
Total	92	100.0

Source: Primary Data, 2025

Based on Table 1, the respondents were predominantly in the mid-adolescent age group, specifically 16 years old (40.2%) and 15 years old (30.4%). Regarding the educational level, the majority of respondents were in Grade X (44.6%) and Grade XI (41.3%), while Grade XII adolescent girls accounted for the lowest participation rate (14.1%).

The independent variable in this study was nutritional status, measured via the BMI-for-Age indicator, while the dependent variable was the incidence of anemia, determined by capillary hemoglobin levels. The frequency distributions of these variables are displayed in Table 2 and Table 3.

Table 2. Frequency Distribution Based on Adolescent girl Nutritional Status

Nutritional Status	Frequency (n)	Percentage (%)
Underweight	16	17.4
Normal	76	82.6
Total	92	100.0

Source: Primary Data, 2025

Referring to Table 2, the majority of the adolescent girls had a normal nutritional status (82.6%). However, underweight nutritional status was still observed in 16 adolescent girls (17.4%). Notably, no adolescent girls in this study sample fell into the overweight or obesity categories.

Table 3. Frequency Distribution Based on Anemia Incidence

Anemia Status	Frequency (n)	Percentage (%)
Anemia (< 12 g/dL)	22	23.9
Non-Anemia (\geq 12 g/dL)	70	76.1
Total	92	100.0

Source: Primary Data, 2025

Table 3 indicates a substantial incidence of anemia within the study population. A total of 22 adolescent girls (23.9%) had hemoglobin levels below the normal threshold (< 12 g/dL), whereas the remaining 70 adolescent girls (76.1%) were categorized as non-anemic.

To test the hypothesis regarding the relationship between nutritional status and the incidence of anemia, a bivariate analysis was conducted using the Pearson Chi-Square test. The cross-tabulation and statistical test results are summarized in Table 4.

Table 4. Relationship between Nutritional Status and Anemia Incidence in Adolescent Girls

Nutritional Status	Anemia		Non-Anemia		Total (n)	χ^2	p-value	PR (95% CI)
	n	%	n	%				
Underweight	5	31.3	11	68.7	16	0.573	0.449	1.40 (0.60 - 3.23) <i>Ref</i>
Normal	17	22.4	59	77.6	76			
Total	22	23.9	70	76.1	92			

Table 4 demonstrates that among the adolescent girls with an underweight

nutritional status, 31.3% (5 individuals) experienced anemia. This proportion is descriptively higher than that of the normal nutritional status group, where 22.4% (17 individuals) were anemic. Despite this descriptive difference, the Chi-Square test yielded a value of $\chi^2 = 0.573$ with a p-value of 0.449. Since the p-value exceeds the significance level ($\alpha = 0.05$), there is no statistically significant relationship between nutritional status and the incidence of anemia. Furthermore, the risk analysis generated a Prevalence Ratio (PR) of 1.40 (95% CI: 0.60 – 3.23). Because the 95% confidence interval crosses the value of 1, it statistically confirms that underweight nutritional status is not a significant risk factor for anemia in this population.

DISCUSSION

This study aimed to analyze the relationship between nutritional status and the incidence of anemia among adolescent girls at SMA Negeri 20 Pangkep. Univariate analysis results showed that the prevalence of anemia in this study population was 23.9%. This figure indicates that anemia remains a significant public health problem according to World Health Organization standards (World Health Organization, 2024).

This finding aligns with recent global health data reported by Belay et al. (2025), which highlights a persistently high prevalence of anemia among adolescents in developing regions. Furthermore, this localized trend mirrors broader international patterns observed by Stevens et al. (2022), indicating that despite various global interventions, adolescent girls remain a highly vulnerable demographic. The high incidence of anemia among adolescent girls in the research location is likely associated with increased iron requirements due to growth spurts and routine blood loss through the menstrual cycle, which are primary physiological characteristics of this age group.

The main finding of this study based on bivariate analysis showed no significant relationship between nutritional status and the incidence of anemia ($p = 0.449$, $\chi^2 = 0.573$). However, the risk analysis demonstrated a Prevalence Ratio (PR) of 1.40 (95% CI: 0.60 – 3.23). This indicates that, descriptively, adolescent girls in the underweight category have a 1.4 times higher prevalence of experiencing anemia compared to those with normal nutritional status. Nevertheless, because the confidence interval crosses the value of 1, this elevated risk is not statistically significant. This result ultimately rejects the assumption that underweight adolescent girls are necessarily more susceptible to anemia.

This finding is consistent with recent research by Liep et al. (2025) and Dhurde et al. (2024), which confirmed that general nutritional status based on Body Mass Index (BMI) is not always a primary determinant of anemia among adolescent girls, as normal body weight does not necessarily reflect adequate iron stores. These studies demonstrate that specific micronutrient profiles and dietary intake often have a more direct impact on hemoglobin levels than basic anthropometric measurements. However, the dynamics of anemia are complex and can vary depending on interventions; for instance, (Nhial and Alemu (2025) highlighted that factors such as the implementation of supplementation programs and localized conditions often shape the anemia risk profile differently across regions. This discrepancy is likely due to differences in respondent characteristics, particularly socioeconomic variations that affect access to nutritious food. Nevertheless, further literature support reinforces the findings of this study by indicating that in rural and developing contexts, the determinants of anemia among adolescent girls are more closely linked to specific dietary inadequacies and sociodemographic factors (Shah et al., 2025).

The absence of a relationship between macro nutritional status (BMI) and

hemoglobin levels can be explained through the phenomenon of "Hidden Hunger." Nutritional status measured by BMI-for-Age reflects the adequacy of energy and protein intake (macronutrients) manifesting in body weight. Conversely, anemia is a manifestation of micronutrient deficiency, particularly iron (Fe), folic acid, and Vitamin B12. As highlighted in recent literature, specific micronutrient deficiencies act as a game-changer for public health interventions. The intake of iron and other micronutrients plays a much more critical role in preventing anemia than mere caloric adequacy (Rahman et al., 2024; Suryanarayana and Rangareddy, 2025).

An adolescent girl with normal nutritional status (ideal weight) may experience "hidden hunger" where her body lacks iron despite sufficient caloric intake. This explains why in this study data, the proportion of normal-weight adolescent girls experiencing anemia (22.4%) was not statistically different from that of underweight adolescent girls (31.3%).

Another factor strongly suspected to contribute to this lack of association is the consumption pattern of iron absorption inhibitors, which is prevalent among adolescents regardless of their nutritional status. Furthermore, poor dietary practices, including the lack of nutritional knowledge and improper consumption habits, significantly impair iron status and increase vulnerability to anemia among adolescents (Rahman et al., 2024). Additionally, menstruation plays a vital role in iron depletion. Recent research confirms that significant menstrual blood loss combined with poor dietary habits are critical drivers of iron deficiency, often outweighing general anthropometric variables in predicting anemia incidence among teenagers (Söderman et al., 2025).

A limitation of this study is the cross-sectional design used, meaning causal relationships cannot be chronologically ascertained. Furthermore, this study only used anthropometric indicators as a determinant of nutritional status without detailed dietary intake data (food recall). Nevertheless, the results of this study provide important clinical and policy implications. Anemia prevention programs, such as the distribution of Iron Supplementation Tablets (TTD) in schools, must target all adolescent girls evenly without screening based solely on physical appearance. Adolescent girls who appear healthy and have proportional bodies should not be overlooked for intervention, as they share an equal risk of experiencing iron deficiency anemia. Furthermore, ensuring consistent adherence to consuming these supplements remains a primary challenge in school-based programs, as noted by Silitonga et al. (2023). To overcome this barrier, Yewodiaw et al. (2025) strongly emphasize that iron supplementation must be integrated with continuous nutritional education media. This recommendation is powerfully corroborated by a recent systematic review from Septiana et al. (2025), which concluded that structured educational media interventions significantly increase self-awareness and guarantee long-term supplement compliance among adolescent girls.

CONCLUSION AND RECOMMENDATION

This study confirms that the prevalence of anemia among adolescent girls at SMA Negeri 20 Pangkep stands at 23.9%, representing a persistent public health concern. Critically, there is no statistically significant relationship between nutritional status (BMI-for-Age) and the incidence of anemia in this population ($p = 0.449$). This finding explicitly demonstrates that a normal anthropometric profile does not guarantee adequate iron reserves, highlighting that anemia among these adolescent girls is fundamentally driven by specific micronutrient deficiencies rather than general caloric inadequacy. Consequently, it is imperative for school administrators and local primary

healthcare centers (Puskesmas) to implement inclusive policies, ensuring the uniform distribution of Weekly Iron and Folic Acid Supplementation (WIFAS/TTD) to all adolescent girls, regardless of their physical appearance or body mass index. This supplementation must be strongly coupled with comprehensive nutritional education to foster sustained adherence. For future research, it is highly recommended to investigate other critical determinants, such as precise dietary intake assessments and menstrual blood loss patterns, to formulate a more holistic understanding of anemia risk factors.

REFERENCES

- Belay, D. G., Amlak, B. T., Chilot, D., Alem, A. Z., & Merid, M. W. (2025). Pooled prevalence of anaemia and its associated factors among adolescent girls in East and West Africa: a systematic review and meta-analysis. *BMC Public Health*, 25(1), 2482. <https://doi.org/10.1186/s12889-025-23701-4>
- Dhurde, V. S., Patel, A. B., Locks, L. M., & Hibberd, P. L. (2024). Anaemia prevalence, its determinants and profile of micronutrient status among rural school adolescent girls aged 14–19 years: a cross-sectional study in Nagpur district, Maharashtra, India. *Public Health Nutrition*, 27(1), e248. <https://doi.org/10.1017/s1368980024002234>
- Ghimire, M., Bhandari, S., & Rajbanshi, M. (2024). Prevalence of anemia and its associated factors among school-going adolescent girls in schools of Dhankuta municipality, Nepal. *PLOS Global Public Health*, 4(9), e0003684. <https://doi.org/10.1371/journal.pgph.0003684>
- Khanal, A., Paudel, R., Wagle, C. N., Subedee, S., & Pradhan, P. M. S. (2024). Prevalence of anemia and its associated factors among adolescent girls on Weekly Iron Folic Acid supplementation (WIFAS) implemented and non-implemented schools at Tokha municipality, Kathmandu. *PLOS Global Public Health*, 4(1), e0002515. <https://doi.org/10.1371/journal.pgph.0002515>
- Liep, N. Van, Huong, N. T. T., Quang, T. D., Lam, N. T., Long, T. H., Anh, L. T. N., & Dung, D. Van. (2025). Anemia in adolescent girls in a northern mountainous province of Vietnam: An analytical cross-sectional study among 805 participants. *Journal of Public Health Research*, 14(4), 22799036251380892. <https://doi.org/10.1177/22799036251380893>
- Maheswari, N., Kandasamy, S., Subbiah, P., Davidson, P. D., Gopal, M., Velappan, L. K., & Kalyanaraman, S. (2024). Adherence to weekly iron folic acid supplementation and associated factors among adolescent girls—A mixed-method study. *Journal of Family Medicine and Primary Care*, 13(6), 2416–2424. https://doi.org/10.4103/jfmpc.jfmpc_1526_23
- Ministry of Health of the Republic of Indonesia. (2020). *Peraturan Menteri Kesehatan Republik Indonesia Nomor 2 Tahun 2020 tentang standar antropometri anak*. Ministry of Health of the Republic of Indonesia. <https://jdih.kemkes.go.id/>
- Nhial, B. C., & Alemu, C. (2025). Anemia and Associated Factors Among Adolescent Girls in Weekly Iron and Folic Acid Supplementation Schools Versus Non-Implemented Schools in Gog and Abobo Woreda, Southwest Ethiopia: A Comparative Cross-Sectional Study. *Health Science Reports*, 8(9), e71247. <https://doi.org/10.1002/hsr2.71247>

- Rahman, M. J., Rahman, M. M., Sarker, M. H. R., Kakehashi, M., Tsunematsu, M., Ali, M., Ahmed, A., Hawlader, M. D. H., & Shimpuku, Y. (2024). Prevalence and influencing factors with knowledge, attitude, and practice toward anemia among school-going adolescent girls in rural Bangladesh. *PloS One*, *19*(11), e0313071. <https://doi.org/10.1371/journal.pone.0313071>
- Sadiq, N., Gul, Y., Bilal, M. M., Afzal, M., Mumtaz, N., Wahid, A., Bilal, M. M., & Wahid Sr, A. (2024). Association between tea drinking and anemia in women of reproductive age: A cross-sectional study from the Mekran division, Balochistan, Pakistan. *Cureus*, *16*(7). <https://doi.org/10.7759/cureus.64801>
- Safiri, S., Kolahi, A.-A., Noori, M., Nejadghaderi, S. A., Karamzad, N., Bragazzi, N. L., Sullman, M. J. M., Abdollahi, M., Collins, G. S., & Kaufman, J. S. (2021). Burden of anemia and its underlying causes in 204 countries and territories, 1990–2019: results from the Global Burden of Disease Study 2019. *Journal of Hematology & Oncology*, *14*(1), 185. <https://doi.org/10.1186/s13045-021-01202-2>
- Sari, P., Herawati, D. M. D., Dhamayanti, M., & Hilmanto, D. (2022). Anemia among adolescent girls in West Java, Indonesia: Related factors and consequences on the quality of life. *Nutrients*, *14*(18), 3777. <https://doi.org/10.3390/nu14183777>
- Septiana, K. S., Adnani, Q. E. S., Susiarno, H., Tarawan, V. M., Arya, I. F. D., & Anwar, R. (2025). The Influence of Anemia Education Media on Increasing Self-Awareness and Compliance in Consuming Iron Supplements in Adolescent Girls: A Systematic Review. *International Journal of Women's Health*, 2277–2289. <https://doi.org/10.2147/ijwh.s532950>
- Shah, R., Tata, L. J., Fogarty, A., Lemanska, A., Kabra, P., & Ahankari, A. (2025). Prevalence and Risk Factors Associated With Anemia in Adolescent Females From Rural Maharashtra, India: Findings From the MAS 2 Project. *Anemia*, *2025*(1), 7015604. <https://doi.org/10.1155/anem/7015604>
- Silitonga, H. T. H., Salim, L. A., Nurmala, I., & Wartiningih, M. (2023). Compliance of iron supplementation and determinants among adolescent girls: A systematic review. *Iranian Journal of Public Health*, *52*(1), 37. <https://doi.org/10.18502/ijph.v52i1.11664>
- Söderman, L., Stubbendorff, A., Ladfors, L. V., Bolmsjö, B. B., Nymberg, P., & Wolff, M. (2025). Exploring the effect of menstrual loss and dietary habits on iron deficiency in teenagers: A cross-sectional study. *PloS One*, *20*(12), e0336688. <https://doi.org/10.1371/journal.pone.0336688>
- Stevens, G. A., Paciorek, C. J., Flores-Urrutia, M. C., Borghi, E., Namaste, S., Wirth, J. P., Suchdev, P. S., Ezzati, M., Rohner, F., & Flaxman, S. R. (2022). National, regional, and global estimates of anaemia by severity in women and children for 2000–19: a pooled analysis of population-representative data. *The Lancet Global Health*, *10*(5), e627–e639. [https://doi.org/10.1016/S2214-109X\(22\)00084-5](https://doi.org/10.1016/S2214-109X(22)00084-5)
- Suryanarayana, R., & Rangareddy, H. (2025). Micronutrient deficiencies and anemia among adolescents in rural south India: A game changer for public health interventions. *Bioinformatics*, *21*(3), 347. <https://doi.org/10.6026/973206300210347>

- World Health Organization. (2024). *Guideline on haemoglobin cutoffs to define anaemia in individuals and populations*. World Health Organization. <https://www.who.int>
- Yeboah, F. A., Bioh, J., Amoani, B., Effah, A., Senu, E., Mensah, O. S. O., Agyei, A., Kwarteng, S., Agomuo, S. K. S., & Opoku, S. (2024). Iron deficiency anemia and its association with cognitive function among adolescents in the Ashanti Region-Ghana. *BMC Public Health*, 24(1), 3209. <https://doi.org/10.1186/s12889-024-20640-4>
- Yewodiaw, T. K., Alemayehu, M. A., & Teshome, D. F. (2025). Anemia status and associated factors among adolescent girls under weekly iron and folic acid supplementation (WIFAS) and non-WIFAS programs in public schools in Janamora district, Northwest Ethiopia 2023; a comparative cross-sectional study. *BMC Nutrition*, 11(1), 50. <https://doi.org/10.1186/s40795-025-01033-1>