Anemia Associated with Student Learning Achievement: Cross-Sectional Study

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ABSTRACT

Introduction: Adolescent anemia is one of the public health problems globally, including in Indonesia. Learning achievement is associated with adolescent anemia in girls. This study aims to determine the relationship between anemia and teenage girls' learning achievement at school.

Methods: The type of research was a cross-sectional study conducted in June 2022 at one of the Aliyah madrasas in Palu City. Research samples from 34 adolescent girls were taken using a simple random technique. The research variables were learning achievement, body mass index (BMI), and hemoglobin levels. Research data was collected using observation sheets, digital weight scales, height using a longboard, and hemoglobin levels using the Easy Touch Kit. The measurement of learning achievement uses the average score of student education reports based on the minimum completeness criteria (CCM) set by the school with the requirements of good (B), enough (C), and less (K). The research data analysis used a chi-square test and prevalence ratio with a confidence level (95%).

Results: The results showed that anemia in adolescent girls was 67.6%. There was an association between learning achievement and anemia (ρ=0.034) and PR value = 0.79, 95% CI 0.00 to 1.52. There was no association between body mass index and anemia (ρ=0.49) and PR value = 0.54, 95% CI 0.08 to 3.7.

Conclusion: The study concluded that the percentage of anemia in adolescent girls was 67.6% and was categorized as a severe public health problem. Teenage girls who are anemic have a risk of 0.79 times having academic achievement with a grade of C. Students are expected to pay attention to adequate nutritional intake; the school facilitates regular iron supplementation intervention programs and nutrition education for vulnerable students, and health programs are integrated with the educational curriculum, health monitoring, and periodic anemia screening.

INTRODUCTION

Adolescent girls' anemia is a moderate to mild public health issue in developed nations (1,2). World Health Organization (WHO) estimates that over two billion people worldwide—or more than 30% of the global population— are anemic. This underscores the significance of anemia as a public health concern in developing and affluent nations. (1). In underdeveloped nations, anemia affects adolescent girls between 42% and 60% of the time (3). In a Tamil Nadu rural area, the frequency of anemia among teenage girls was 48.63% in India (4). In Ethiopia, 44% of teenage girls suffer from anemia (5). Province by Province in Indonesia, adolescent girls' anemia prevalence varies. In 2018, a health test in Rejang Lebong District revealed that 53.8% of teenage girls suffered from anemia (6). In West Java, 14.3% of teenage girls suffer from anemia (7). A study in a rural area of Jatinangor found that iron deficiency anemia was 21.1% among adolescent girls (8). In Sigi Regency, Central Sulawesi, adolescent girls' anemia prevalence is 20.3% (9).

Adolescent females are susceptible to iron deficiency and anemia because of several variables, such as high rates of infection and worm infestation, pregnancy, and inadequate dietary intake of iron. Compared to their male counterparts, teenage girls are more likely to experience anemia (10–14). Anemia can adversely affect cognitive performance, physical capacity, and work performance (10,11,15,16). According to studies, anemia has been linked to reduced bodily resistance, weakness, appetite, poor focus, and lower academic achievement. Anemia can weaken the immune system, making students more susceptible to infections and illnesses, negatively impacting their academic performance (17,18). Anemia can cause fatigue and difficulty concentrating, affecting students' ability to focus on their studies and perform well academically (19,20). Anemia can lead to decreased learning achievement, as students may struggle to absorb and retain information due to their weakened physical condition (12,21,22).

The Government of the Republic of Indonesia has implemented various efforts to prevent anemia among adolescent girls. These efforts include education on balanced nutrition, food fortification, and supplementation of Blood-Adding Tablets (BAD) (23). Giving BAD to adolescent girls has been done, but the prevalence of anemia is still relatively high. Many factors influence this, one of which is the lack of adherence of adolescent girls to iron tablets (24). The government has partnered with Nutrition International to protect teenage girls from anemia through nutrition education and weekly iron and folic acid supplementation. In addition, school-based multisectoral collaborative projects have been implemented to prevent anemia among adolescent girls in Indonesia. This project highlights the potential benefits of weekly iron and folic acid supplementation and anemia prevention for school performance (25,26). The impact of anemia is significant on adolescent health, and efforts to reduce anemia problems are among the World Health Assembly's Global Nutrition Targets for 2025 and Sustainable Development Goal (7). Central Sulawesi Provincial Health Office has also made efforts to reduce the anemia rate of adolescent girls by providing blood-added tablets. The BAD target for teenage girls in Central Sulawesi in 2022 is 50%, which is realized at 46.5%.

Adolescent girls who received BAD in Palu City in 2022 reached 36.3%. The achievement of giving BAD in Palu City was still higher than Donggala Regency's 19.6% and Sigi's 14.6% (9.20). However, the incidence of severe anemia in adolescent girls in Palu City is still high (27). Compliance was one of the causes of the high incidence of anemia, especially severe anemia in Palu City. Previous research in Palu City related to anemia in adolescent girls showed that adolescent girl anemia was related to knowledge and socioeconomics (21). Research on the impact of anemia on learning achievement in teenage girls in Palu City has never been conducted nor published. Knowing the effects of anemia on adolescent girls in schools is a consideration for schools and local governments to determine anemia control policies. This study aims to determine the relationship between anemia and teenage girls' learning achievement in school.

METHOD

This type of research was cross-sectional. The research was conducted in June 2022 at Madrasah Aliyah Negeri (MAN) Insan Cendekia Palu City. The population of the study was 39 third-grade students. The study sample was 34 people who were taken using a simple randomization technique. The research variables were learning achievement, hemoglobin levels, and body mass index (BMI). Learning achievement was the average score of the odd semester education report of female students as measured by a score of a (92-100), B (83-91), and C (75-82). BMI was produced by dividing body weight (Kg) by height (M2). The hemoglobin level was the amount of red blood cell pigment in the blood, which was split into anemia (<12 mg/dl) and non-anemia (≥12 mg/dl).

Before the research was conducted, respondents were explained and asked for voluntary consent to become a research sample. The collection of research data was carried out using observation sheets. Weight measurement using digital weight scales, height using a Body Length Measuring Instrument, and hemoglobin levels using the Easy Touch Kit. Health workers examined respondents' hemoglobin levels. The measurement of learning achievement uses the average score of student education reports based on the school's minimum completeness criteria. The research data analysis used the chi-square test and prevalence ratio with a confidence level of 95%.

Ethical Consideration

All the ethical principles in research involving human subjects were incorporated in this study. Written and informed consent was obtained through clear explanations of the study's objectives, procedures, potential risks, and benefits before participation. Participation was assured to be confidential, anonymous, and voluntary, with withdrawal at any moment without consequences.

RESULTS

The results of the study can be seen as follows:

Table 1. Frequency Distribution of Respondent Characteristics (n=34)

Characteristics of Respondents	Frequency (n)	Percentage (%)
Age (years)		
15	15	44.12
16	18	52.94
17	1	2.94
Hemoglobin level		
Anemia	23	67.6
Normal	11	32.4
BMI		
Normal	28	82.4
Underweight	6	17.6
Odd Semester Average Score		
B	26	76.47
C	8	23.53

Table 1 shows the % of anemic female students was 23 people (67.6%). The characteristics of most respondents were the age of 16 years, as many as 18 people (52.94%), the BMI of expected respondents, as many as 28 people (82.4%), and the average score of odd semester respondents, namely B as many as 26 people (76.47%).

Table 2. The Relationship between Anemia and Learning Achievement of Class X Science Young Women at MAN Insan Cendekia Kota Palu

Hemoglobin Level	Learning Performance				PR	95%CI	ρ Value
	B		C				
	f	%	F	%			
Anemia	15	65.2	8	34.8	0.079	0.00-1.52	0.034
Normal	11	100	0	0			

Table 2 shows a relationship between hemoglobin levels and learning performance. The table shows that in the group with anemia, 65.2% showed low learning performance, while only 34.8% had good learning performance. In contrast, all (100%) showed good learning performance in the group with normal hemoglobin levels. An odds ratio (OR) value of 0.0793 with a confidence interval (95% CI) between 0.004 and 1.516 indicates that respondents with anemia have a lower likelihood of having good learning performance compared to those with normal hemoglobin levels. A p-value of 0.034 indicates that this result is statistically significant, suggesting a meaningful relationship between hemoglobin levels and learning performance.

Table 3. The Relationship between BMI and Learning Achievement of Class X Science Young Women in MAN Insan Cendekia Kota Palu

BMI	Learning Performance				PR	95%CI	ρ Value
	B		C				
	f	%	f	%			
Underweight	4		2		0.54	0.08 - 3.7	0.49
Normal	22		6				

Table 3 shows the relationship between body mass index (BMI) and learning performance. In the underweight group, four respondents (out of the total observed) showed low learning performance, while two had good learning performance. In contrast, in the group with a normal BMI, 22 respondents had low learning performance, while six respondents showed good learning performance. An odds ratio (OR) value of 0.545 with a confidence interval (95% CI) between 0.080 and 3.715 indicated that the difference in learning performance between underweight and expected-weight respondents was not statistically significant. A p-value of 0.49 suggests no significant association between BMI and learning performance in this sample.

DISCUSSION

The percentage of anemia based on the study's results was 67.6%. This data shows that out of 10 adolescent girls, there are 6-7 people who have anemia. This percentage is classified as a severe public health problem. Because of the significant impact of anemia, the school should pay more attention to anemia experienced by adolescent girls. The high prevalence of anemia is attributed to various factors, including iron deficiency, acute and chronic infections, deficiencies of vitamins and minerals (such as folate, vitamin B12, and vitamin A), genetically inherited traits (e.g., thalassemia), and other conditions like malaria, HIV/AIDS, and cancer. In addition, factors such as poor dietary iron intake, inadequate absorption of iron, and blood loss contribute to the risk of iron-deficiency anemia. The vulnerable groups, such as children, pregnant women, and the poorest and least educated populations, are disproportionately affected by iron deficiency anemia (28). Other determinants of anemia prevalence include socio-demographic factors, altitude, smoking behaviour, and pregnancy status (29). The burden of anemia and its underlying causes remains a significant global health concern, affecting a large number of respondenals, particularly women and children (30). Efforts to address anemia include improving access to healthcare services, screening, prevention, and treatment, as well as addressing factors such as poverty, social inequality, and nutritional deficiencies.

The results showed that anemia was associated with adolescent girls' learning achievement. This study aligns with the finding that anemia is associated with adolescent girls' learning achievement. (31). Several studies have highlighted the relationship between anemia and learning achievement in school children and adolescents (31–35). One study found a significant association between anemia and the learning achievement of adolescent girls (34). Another study showed that web-based anemia education could improve teenage girls' knowledge, attitudes, and practices (32). However, the causal relationship between anemia and learning achievement is still unclear, and these studies have some limitations (33).

The results also show no relationship between body mass index (BMI) and learning achievement. BMI is a measure used to measure a person's nutritional status, obtained by dividing body weight by height. The results of research on the relationship between BMI and anemia are different. Some studies state there is a relationship, and other studies state there is no relationship. A study conducted in China found that overweight and obese women had a lower prevalence of anemia than normal-weight women (36). Another study in Indonesia found that underweight adolescent girls had a greater risk of experiencing anemia than girls with standard BMI categories (37). However, the evidence published supporting the association between BMI and anemia is controversial, with some studies reporting a direct association while others reporting the opposite or no relationship (38). Therefore, the relationship between BMI and anemia in women is still not fully understood and requires further investigation.

In addition to signs including paleness, tiredness, decreased appetite, and growth abnormalities, anemia in adolescent girls can cause diminished physical resistance, weakness, impaired focus, and decreased academic accomplishment (31,32,34,35). The long-term effects of anemia in teenage girls can be significant and may persist into adulthood. Anemia during childhood has been associated with changes in cerebral function, affecting the ability to learn and potentially leading to long-lasting effects on the auditory and visual systems (39). Chronic anemia can

negatively impact linear growth during all stages of development, including infancy, childhood, and adolescence. In severe cases, anemia may lead to delayed growth and long-term effects on neurodevelopment (40). Decreased concentration and achievement in adolescents can lead to reduced productivity, which may result in low incomes as adults. Anemia during pregnancy can hinder fetal development, leading to premature birth with low body weight and short stature. Anemia increases the risk of stunting and impaired intelligence development in children. Anemia during pregnancy can also pose risks to the mother, such as an increased risk of bleeding and potential complications during childbirth (23). In summary, anemia in adolescent girls can have long-term effects on cognitive development, growth, productivity, intelligence development, and maternal health. It is essential to address anemia in adolescents to prevent these potential adverse outcomes.

Although this study has found that there is a relationship between anemia and academic achievement in adolescent girls, this is still debatable. Because many factors affect students' learning achievement, this study uses a cross-sectional method, so it is impossible to know which variables cause (risk factors) and which are the consequences (effects). Therefore, it is essential to conduct further research to explore the determinants of student learning achievement with the control case or cohort method.

Limitation and Implication

This study has several limitations, including a cross-sectional design that does not allow for determining cause-and-effect relationships, coverage that is limited to one school so that it is less representative of the wider population, and measurement of academic achievement that only uses report cards without taking into account other cognitive aspects. In addition, confounding factors such as nutritional intake, socioeconomic status, and iron supplementation compliance were not fully accounted for. Nevertheless, the results of this study imply the need for school-based health interventions through routine anemia screening, nutrition education, and iron supplementation programs, as well as collaboration between policymakers and educational institutions to integrate health promotion in the school curriculum. Further research with wider coverage and longitudinal methods is needed to better understand the impact of anemia on academic performance.

CONCLUSION

The study concluded that the percentage of anemia in adolescent girls was 67.6% and was categorized as a severe public health problem. Teenage girls who are anemic have a risk of 0.79 times having academic achievement with a grade of C. Students are expected to pay attention to adequate nutritional intake; the school facilitates regular iron supplementation intervention programs and nutrition education for vulnerable students, and health programs are integrated with the educational curriculum, health monitoring, and periodic anemia screening.

AUTHOR'S CONTRIBUTION STATEMENT

The work reported was significantly enhanced by the contributions of all authors, who took part in the drafting, revising, or critical review of the article, approved the final version to be published, agreed on the journal to which the article has been submitted, and agreed to take responsibility for all aspects of the work. The author's contribution includes conception, study design, execution, data acquisition, analysis, and interpretation, among other areas.

CONFLICTS OF INTEREST

The author states this study has no conflict of interest with any party.

BIBLIOGRAPHY

1. Kounnavong S, Vonglokham M, Kounnavong T, Kwadwo DD, Essink DR. Anaemia among adolescents: assessing a public health concern in Lao PDR. Glob Health Action. 2020 Jul;13(sup2):1786997.

2. Gebreyesus SH, Endris BS, Beyene GT, Farah AM, Elias F, Bekele HN. Anaemia among adolescent girls in three districts in Ethiopia. BMC Public Health. 2019 Dec;19(1):92.

3. Prasanth R. Prevalence of Anemia in both Developing and Developed Countries around the World. World J Anemia. 2017 Jun;1(2):40–3.

4. Chowdhury S, Chakraborty P pratim. Prevalence of Anemia Among Adolescent Girls in a Rural Area of Tamil Nadu, India. J Fam Med Prim Care. 2017;6(2):169–70.

5. Regasa RT, Haidar JA. Anemia and its determinant of in-school adolescent girls from rural Ethiopia: a school based cross-sectional study. BMC Womens Health. 2019 Dec;19(1):98.

6. Jumiyati J, Wahyu W T, Krisnasary A, Yulianti R. Anemia among Adolescent Girls: Its Association with Protein and Iron Intake. Media Gizi Indones. 2023 Jun;18(1SP):14–20.

7. Sari P, Herawati DMD, Dhamayanti M, Hilmanto D. Anemia among Adolescent Girls in West Java, Indonesia: Related Factors and Consequences on the Quality of Life. Nutrients. 2022 Sep;14(18):3777.

8. Sari P, Judistiani RTD, Herawati DMD, Dhamayanti M, Hilmanto D. Iron Deficiency Anemia and Associated Factors Among Adolescent Girls and Women in a Rural Area of Jatinangor, Indonesia. Int J Womens Health. 2022 Aug;Volume 14:1137–47.

9. Taqwin, Amsal, Batjo SH, Radhiah S, Ramadhan K, Erma D, Hafid F, Hariadha E, et al. Uncovering Determinant of Anaemia Among Adolescent Girls. Poltekita J Ilmu Kesehat. 2023;17(3):1125–35.

10. Yetti RE, Tombeg Z, Hadi AJ, Sudarman S, Ishak S, Handayani FR. An Exploration of Determinants of Anemia in Pregnant Women at Buakayu Community Health Center Tana Toraja Regency. J Public Heal Pharm. 2024;4(1):1–9.

11. Fauzia VN, Sutrisminah E, Meiranny A. Relationship Between Anemia in Pregnant Women and the Incidence of LBW: Literature Review | Hubungan Anemia pada Ibu Hamil dengan Kejadian BBLR: Literature Review. Media Publ Promosi Kesehat Indones. 2024;7(4):795–804.

12. Kario AJ, Kurniawan R. Prediction of Anemia Using Machine Learning Algorithms: Scoping Review. Media Publ Promosi Kesehat Indones. 2024;7(11):2614–23.

13. Riberu MDP, Marni M, Ndun HJN. Cultural Factors Influencing the Incidence of Chronic Energy Deficiency (CED) in Pregnant Women in the Langke Majok Health Center Work Area. Media Publ Promosi Kesehat Indones. 2024;7(11):2764–7.

14. Yuniarti A, Setiarini A. Consumption of Vitamin A to Prevent Stunting Incidents: Systematic Review | Konsumsi Vitamin A untuk Mencegah Kejadian Stunting: Systematic Review. Media Publ Promosi Kesehat Indones. 2024;7(3):588–95.

15. Sartika AN, Khoirunnisa M, Meiyetriani E, Ermayani E, Pramesthi IL, Nur Ananda AJ. Prenatal and postnatal determinants of stunting at age 0-11 months: A cross-sectional study in Indonesia. PLoS One. 2021;16(7):e0254662.

16. Rachmi CN, Wulandari E, Kurniawan H, Wiradnyani LAA, Ridwan R, Akib TC. Aksi Bergizi Hidup Sehat Sejak Sekarang untuk Remaja Kekinian Penanggung. Unicef. Jakarta Selatan: Kementerian Kesehatan RI; 2019. 1–188 p.

17. Hlatswayo BPS, Ntshangase S, De Villiers FPR. The effects of iron deficiency and anaemia on primary school learners' scholastic performance. South African J Child Heal. 2016 Jun;10(2):111.

18. Gedefaw L, Tesfaye M, Yemane T, Adisu W, Asres Y. Anemia and iron deficiency among school adolescents: burden, severity, and determinant factors in southwest Ethiopia. Adolesc Health Med Ther. 2015 Dec;189.

19. Tayyab H, Hashmi S, Ismail B, Tayyab M, Aftab K. Difference of academic achievement between anemic and non anemic student of primary grade school going . 2023;(July).

20. Sepriadi, Eldawaty. The Contribution of Hemoglobin Levels to Students' Physical Fitness. J Phys Educ Sport Heal Recreat. 2019;8(2):82–90.

21. Erni Yetti R, Tombeg Z, Hadi AJ, Sudarman S, Ishak S, Handayani FR. An Exploration of Determinants of Anemia in Pregnant Women at Buakayu Community Health Center Tana Toraja Regency. J Public Heal Pharm [Internet]. 2024;4(1):1–9. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-

85193916894&doi=10.56338%2Fjphp.v4i1.5041&partnerID=40&md5=45678bf7764271fa3ecddd1857d48c57

22. Sulistiani RP, Fitriyanti AR, Dewi L. Pengaruh Edukasi Pencegahan Anemia dengan Metode Kombinasi Ceramah dan Team Game Tournament pada Remaja Putri. Sport Nutr J. 2021;3(1):39–47.

23. Sherly. Faculty of Public Health News Indonesia University. 2023. 1 in 4 Young Women Suffers from Anemia, can Cause Stunting and Requires Serious Treatment.

24. Kementerian Kesehatan R.I. Kemenkes R.I. 2022. Nutrition Action: Healthy Movement for Teens.

25. International N. Nutrition International. 2019. Nutrition International and Government of Indonesia collaboration protects adolescent schoolgirls from anaemia.

26. Roche ML, Bury L, Yusadiredja IN, Asri EK, Purwanti TS, Kusyuniati S, et al. Adolescent girls' nutrition and prevention of anaemia: a school based multisectoral collaboration in Indonesia. BMJ. 2018 Dec;k4541.

27. Kumparan.Com. Kumparan.Com. 2022. Kasus Anemia Berat di Kota Palu Masih Tinggi.

28. WHO. WHO. 2023. p. 1 Anaemia.

29. Gautam S, Min H, Kim H, Jeong HS. Determining factors for the prevalence of anemia in women of reproductive age in Nepal: Evidence from recent national survey data. Kabir R, editor. PLoS One. 2019 Jun;14(6):e0218288.

30. Safiri S, Kolahi AA, Noori M, Nejadghaderi SA, Karamzad N, Bragazzi NL, et al. Burden of anemia and its underlying causes in 204 countries and territories, 1990–2019: results from the Global Burden of Disease Study 2019. J Hematol Oncol. 2021 Nov;14(1):185.

31. Suryati Y, Yuniarti S, Runy Anggiyani I. Correlation of Anemia With Achievement Index in Female Adolescents in Junior High School. KnE Med. 2022 Jun;

32. Ernawati E, Baso YS, Hidayanty H, Syarif S, Aminuddin A, Bahar B. effects of anemia education using web-based she smart to improve knowledge, attitudes, and practice in adolescent girls. Int J Heal Med Sci. 2022 Jan;5(1):44–9.

33. Mosiño A, Villagómez-Estrada KP, Prieto-Patrón A. Association between School Performance and Anemia in Adolescents in Mexico. Int J Environ Res Public Health. 2020 Feb;17(5):1466.

34. Suprayogi D, Khamidah A, Aprilia F, Khasanah KD, Pribadi ET. Literature Review: Association of Iron Deficiency Anemia with Cognitive Function in Adolescents. Proc Int Conf Halal Food Heal Nutr. 2023 Feb;1(1):100–6.

35. Setiarsih D, Kardina RN, Santoso APR, Kaunain AM, Afifah H. Analysis of Anemia Incidence Determinants among Female Students at Islamic Boarding School Al Hidayah 2 Bangkalan. J Ners dan Kebidanan (Journal Ners Midwifery). 2022 Aug;9(2):148–53.

36. Qin Y, Melse-Boonstra A, Pan X, Yuan B, Dai Y, Zhao J, et al. Anemia in relation to body mass index and waist circumference among chinese women. Nutr J. 2013 Dec;12(1):10.

37. Enggardany R, Hendrati LY, Hairi NN. Relationship between Body Mass Index (BMI) and Anemia Among Adolescent Indonesian Girls (Analysis of The Indonesia Family Life Survey 5th Data). Amerta Nutr. 2021 Nov;5(4):347.

38. Kamruzzaman M. Is BMI associated with anemia and hemoglobin level of women and children in Bangladesh: A study with multiple statistical approaches. Kabir E, editor. PLoS One. 2021 Oct;16(10):e0259116.

39. Juffrie M, Helmyati S, Hakimi M. Nutritional anemia in Indonesia children and adolescents: Diagnostic reliability for appropriate management. Asia Pac J Clin Nutr. 2020;29(December):18–31.

40. Soliman A, De Sanctis V, Kalra S. Anemia and growth. Indian J Endocrinol Metab. 2014;18(7):1.