Jurnal Info Kesehatan
Vol. 23, No. 4, Desember 2025, pp. 737-745
P-ISSN 0216-504X, E-ISSN 2620-536X
DOI: *10.31965/infokes.Vol23.Iss4.2167*
Journal homepage: https://jurnal.poltekkeskupang.ac.id/index.php/infokes

RESEARCH **Open Access**

Dietary Patterns as Determinants of Ferritin Status in Adolescent Girls

Tera Octavia[1a*], Ani Margawati[1b], Edward Kurnia Setiawan Limijadi[2c]

[1] Department of Nutrition, Faculty of Medicine, Universitas Diponegoro, Semarang City, Central Java, Indonesia
[2] Department of Clinical Pathology, Faculty of Medicine, Universitas Diponegoro, Semarang City, Central Java, Indonesia

[a] Email: teraoctaviana239@gmail.com
[b] Email: animargawati@gmail.com
[c] Email: edwardksl@fk.undip.ac.id

Received: 2 October 2025 Revised: 16 December 2025 Accepted: 21 December 2025

Abstract
Iron deficiency, commonly indicated by low ferritin concentrations, remains a major nutritional problem among adolescent girls and poses risks to growth, cognitive development, and long-term health. While previous studies have largely focused on single nutrients or iron intake, evidence on the relationship between overall dietary patterns and ferritin status among Indonesian adolescents is limited. This study aimed to examine the association between dietary patterns and ferritin status among adolescent girls in Pekalongan, Indonesia. A cross-sectional study was conducted among 80 adolescent girls aged 15–19 years. Serum ferritin levels were measured using ELISA, and dietary patterns were derived using pattern-based dietary assessment. Age, nutrition knowledge, body mass index, physical activity, and hemoglobin concentration were also examined as potential correlates. Dietary pattern was significantly associated with ferritin status, with poorer dietary patterns linked to lower ferritin concentrations. In contrast, no significant associations were observed for body mass index, physical activity, hemoglobin levels, or other individual characteristics, suggesting that overall dietary quality may play a more prominent role in iron stores than single anthropometric or behavioral factors. Given the cross-sectional design and modest sample size, causal inference and generalizability are limited. Nevertheless, the findings highlight the potential value of improving dietary quality through adolescent-focused nutrition education and school-based nutrition strategies to support iron status and reduce the risk of iron deficiency in this population.

Keywords: Adolescent Girls, Dietary Patterns, Ferritin Status, Iron Deficiency, Nutrition Education.

Corresponding Author:

Tera Octavia
Department of Nutrition, Faculty of Medicine, Universitas Diponegoro, Semarang City, Central Java, Indonesia
Email: teraoctaviana239@gmail.com

1. INTRODUCTION

Iron deficiency remains one of the most prevalent nutritional problems among adolescent girls worldwide, adversely affecting growth, cognitive development, physical performance, and overall health (Yunanci et al., 2023). Adolescence represents a critical period characterized by rapid physical growth, increased blood volume, and the onset of menstruation, all of which elevate iron requirements (Soliman et al., 2022). Ferritin, a blood protein that reflects the body's iron stores, is widely recognized as a reliable biomarker for assessing ferritin status. Low ferritin levels indicate depleted iron reserves, which can progress to anemia if not addressed (World Health Organization, 2020). Iron deficiency anemia has been associated with fatigue, reduced school performance, compromised immunity, and long-term health consequences, highlighting the importance of monitoring ferritin status in this population (Kolarš et al., 2025; Obeagu, 2025; Samson et al., 2022).

In Indonesia, adolescent girls are particularly susceptible to ferritin deficiency due to dietary patterns that often lack diversity and are low in iron-rich foods such as meat, legumes, and fortified products (Knijff et al., 2021). Previous studies have shown that inadequate intake of macro and micronutrients, poor meal frequency, and low nutrition knowledge contribute to suboptimal ferritin levels among adolescents (Abu-Baker et al., 2021; Ayal et al., 2022; Cohen & Powers, 2024). However, much of the existing research has focused on single nutrient intake rather than overall dietary patterns, limiting the understanding of how habitual eating behaviors influence iron status (Stubbendorff et al., 2025). Recent evidence suggests that examining dietary patterns as a whole can provide a more comprehensive assessment of nutritional quality and its relationship with health outcomes (English et al., 2021; Gherasim et al., 2020; Vajdi & Farhangi, 2020).

Dietary patterns among adolescents are shaped by multiple interrelated factors, including nutrition knowledge, cultural food practices, household food availability, and school food environments (Ajetunmobi & Laobangdisa, 2024; Bennett et al., 2022; Hassan et al., 2020). Nutrition knowledge has been shown to influence food choices, but even with good knowledge, adolescent girls may not consistently adopt healthy dietary patterns due to external factors such as school environment, family habits, and availability of foods (Islam et al., 2019; Mama Chabi et al., 2022). Examining nutrition knowledge alongside dietary patterns therefore provides a more nuanced understanding of how dietary behaviors relate to ferritin status, without implying direct causation (Conrad et al., 2024; Ge et al., 2025).

Despite these known factors, there remains limited empirical evidence from Indonesia linking dietary patterns with biochemical indicators of ferritin status among adolescent girls (Putri et al., 2025). Most existing studies focus on self-reported anemia or hemoglobin levels alone, which may not fully reflect iron reserves. By directly measuring ferritin levels, this study addresses a critical gap in understanding the nutritional determinants of iron deficiency and provides objective data to guide interventions. Pekalongan was selected as the study site due to its mixed urban–peri-urban characteristics, which reflect dietary transitions commonly observed in many Indonesian secondary cities. These transitions are often accompanied by increased consumption of energy-dense but micronutrient-poor foods, potentially heightening the risk of hidden hunger, including iron deficiency, among adolescents. However, local evidence on dietary patterns and biochemical iron status in this setting remains limited, restricting the development of context-specific nutrition interventions. Therefore, this study aims to examine the association between dietary patterns and ferritin status among adolescent girls in Pekalongan, Indonesia.

2. RESEARCH METHOD

This study employed a quantitative observational design with a cross-sectional approach. Data collection was conducted from February to March 2025 in the working area of Puskesmas Doro I, Pekalongan Regency, Indonesia.

The study population comprised adolescent girls enrolled in three high schools within the Puskesmas Doro I catchment area: SMA N 1 Doro, SMK Muhammadiyah Doro, and SMK Ma'arif NU. The minimum required sample size was calculated using Lemeshow's formula for cross-sectional studies, yielding 69.86 participants. To account for potential non-response and incomplete data, a 15% adjustment was applied, resulting in a final sample size of 80 participants. Proportional random sampling was used to allocate samples across the three schools, followed by simple random sampling to select participants, ensuring equal probability of inclusion.

Inclusion criteria were adolescent girls who were able to communicate effectively, had regular menstrual cycles, provided written informed consent, were free from chronic conditions known to affect iron metabolism, and were able to complete dietary and nutrition-related assessments. Exclusion criteria included current use of iron supplements, withdrawal during blood collection, or incomplete dietary records or SQ-FFQ data.

Serum ferritin concentration (ng/mL) was measured using the enzyme-linked immunosorbent assay (ELISA) method as a dependent variable. Ferritin was analyzed as a continuous variable for multivariate analysis to preserve statistical power. For descriptive purposes, ferritin status was also categorized as iron deficiency (<45 ng/mL) and non-deficiency (≥45 ng/mL). The cut-off of <45 ng/mL was selected based on emerging evidence suggesting that higher ferritin thresholds may better reflect depleted iron stores among menstruating adolescent girls and populations at risk of functional iron deficiency, particularly in low- and middle-income settings. This approach has been recommended in recent epidemiological studies to improve sensitivity in identifying early iron depletion beyond overt anemia. Independent variables included age in years, nutrition knowledge classified as good or poor, dietary pattern assessed via SQ-FFQ and categorized as good or poor, body mass index (kg/m^2), physical activity categorized as low, medium, or high, and hemoglobin level (g/dL) measured using a Hematology Analyzer.

Univariate analysis was performed to describe mean scores, standard deviations, and frequencies of ferritin status and independent variables, including dietary patterns, nutrition knowledge, age, BMI, physical activity, and hemoglobin levels. Bivariate analysis was conducted to assess the relationship between each independent variable and ferritin status using Pearson correlation test, Spearman correlation test, T-Test, and ANNOVA. For normally distributed data Shapiro-Wilk test (swilk) was used. In regression analysis, a VIF value less than 5 indicates no significant multicollinearity (safe), a VIF between 5 and 10 suggests potential multicollinearity that requires attention, while a VIF greater than 10 signifies serious multicollinearity and the regression model should be corrected. Multivariate analysis employed multiple linear regression to examine the strength and significance of associations with statistical significance was set at $p < 0.05$.

This study was conducted following ethical standards and received approval from the Komisi Etik Penelitian Kesehatan, Fakultas Kedokteran, Universitas Diponegoro with No.045/EC/KEPK/FK-UNDIP/III/2025.

3. RESULTS AND DISCUSSION

Table 1. Characteristics of the respondents

Variable (n = 80)	Mean	Std deviation	Min - Max
Ferritin Status (ng/mL)	33.11	29.87	4 - 170
Aged (Years)	15.74	0.71	15 - 17

Nutrition Knowledge	**Frequency**	**Percentage**	
Good	67	83.75	
Poor	13	16.25	
Dietary Pattern	**Frequency**	**Percentage**	
Goor	62	77.5	
Poor	18	22.5	
Body Mass Index (kg/m2)	24.76	6.40	14.88 - 39.54
Physical Activity	**Frequency**	**Percentage**	
Low	12	15.00	
Medium	19	23.75	
High	49	61.25	
Hb Status (g/dL)	13.90	0.95	11.2 - 16.1

Table 1 shows that the study involved 80 adolescent girls with a mean age of 15.74 years (range 15–17). The average ferritin level was 33.11 ng/mL, ranging from 4 to 170 ng/mL, indicating considerable variation among participants. Most respondents demonstrated good nutrition knowledge (83.75%) and adhered to a healthy dietary pattern (77.5%). The mean body mass index was 24.76 kg/m², with values ranging from 14.88 to 39.54 kg/m², suggesting some participants were underweight or overweight. Regarding physical activity, the majority engaged in high activity levels (61.25%), while 23.75% and 15% reported medium and low activity, respectively. Hemoglobin levels averaged 13.90 g/dL (range 11.2–16.1 g/dL), which generally falls within the normal range for adolescent females.

Table 2. Bivariate analysis of each independent variable to ferritin status

Independent variable (n = 80)	**Category/ type**	**Association**	***p-value***
Aged (Years)*	Continuous	0.1321	0.243
Nutrition Knowledge^			**0.001**
	Good	37.72 + 30.42	
	Poor	9.38 + 7.30	
Dietary Pattern^			**0.000**
	Good	40.26 + 30.17	
	Poor	8.50 + 7.11	
Body Mass Index (kg/m2)#	Continuous	0.30	**0.006**
Physical Activity+	Between groups	2.30	0.107
Low	Within groups		
Medium			
High			
Hemoglobin Status (g/dL)#	Continuous	0.28	**0.013**

Exp: *('*'= Pearson correlation test), ('#'=Spearman correlation test, ('^'=t-test) ,('+' ANNOVA)*

Table 2 shows that the bivariate analysis revealed that ferritin status was significantly associated with knowledge (p = 0.001) and dietary pattern (p = 0.000), with higher ferritin levels observed in participants with good knowledge (37.72 ± 30.42 ng/mL) and good dietary patterns (40.26 ± 30.17 ng/mL). Body mass index (BMI) (r = 0.30, p = 0.006) and hemoglobin (Hb) levels (r = 0.28, p = 0.013) also showed significant positive correlations with ferritin status. In contrast, age (r = 0.1321, p = 0.243) and physical activity (F = 2.30, p = 0.107) were not significantly associated with ferritin levels. Pearson correlation was used for age, Spearman correlation for BMI and Hb, t-test for knowledge and dietary pattern, and ANOVA for physical activity.

Table 3. The regression model was tested for multicollinearity using Variance Inflation Factor (VIF).

	Aged	Knowledge	Dietary Pattern	BMI	Physical Activity	Hb Status
Aged	1					
Knowledge	0.0681	1				
Dietary Pattern	-0.0117	0.4741	1			
BMI	0.1001	-0.3706	-0.3032	1		
Physical Activity	-0.079	-0.0006	-0.0535	-0.0021	1	
Hb Status	-0.055	-0.4292	-0.3252	0.361	-0.0705	1

Table 3 shows that the regression model was assessed for multicollinearity using correlation coefficients and the Variance Inflation Factor (VIF). The intercorrelations among independent variables were generally low to moderate, with the highest correlations observed between knowledge and dietary pattern (r = 0.4741) and Hb status and knowledge (r = -0.4292). These values suggest no serious multicollinearity issues in the model, indicating that the independent variables can reliably be included in the regression analysis.

Table 4. The result of linear regression analysis for all variables among the ferritin status

Ferritin status (n = 80)	Coefficien	Std. error	t	*p-value*	[95% conf.interval]	
					Lower	Upper
Aged (Years)	3.85	4.35	0.89	0.379	-4.82	12.52
Knowledge						
Good	*ref*					
Poor	-13.66	10.87	-1.26	0.213	-35.32	8.01
Dietary Pattern						
Goor	*ref*					
Poor	-20.90	9.05	-2.31	0.024	-38.94	-2.85
Body Mass Index (kg/m2)	0.31	0.52	0.60	0.549	-0.73	1.36
Physical Activity						
Low	*ref*					
Medium	11.66	10.31	1.13	0.262	-8.89	32,21
High	-4.31	8.66	-0.50	0.621	-21.58	12,97
Hemoglobin Status (g/dL)	1.83	3.60	0.51	0.613	-5.34	9.00
cons	-53.88	86.27	-0.62	0.534	-225.85	118.09

Table 4 shows that the linear regression analysis indicated that dietary pattern was the only significant predictor of ferritin status (β = -20.90, p = 0.024), with participants having a poor dietary pattern showing lower ferritin levels compared to those with a good dietary pattern. Other variables, including age (p = 0.379), knowledge (p = 0.213), BMI (p = 0.549), physical activity (p > 0.05), and hemoglobin levels (p = 0.613), were not significantly associated with ferritin status in the multivariate model. This suggests that among the factors studied, dietary quality plays a key role in determining ferritin levels in adolescent girls.

The dietary pattern was the only significant predictor of ferritin status among adolescent girls in Pekalongan, with a poor dietary pattern associated with lower ferritin levels (β = -20.90, p = 0.024). This finding underscores the critical role of overall dietary quality in maintaining adequate iron stores during adolescence. Adolescents with poor dietary patterns may consume insufficient iron-rich foods or lack dietary diversity, directly affecting ferritin levels and increasing the risk of iron deficiency. These results align with studies from various regions that adolescents adhering to snack and fast-food patterns had a higher risk of iron deficiency, while those following meat and offal patterns had a lower risk (Fu et al., 2024; Ma et al., 2023; Soans et al., 2025). Similarly, research in Sweden found that teenage girls following plant-based diets had a higher prevalence of iron deficiency compared to omnivores (Hallström et al., 2025; Stubbendorff et al., 2025).

Other variables, including age, nutrition knowledge, BMI, physical activity, and hemoglobin status, were not significantly associated with ferritin levels in this study. Although nutrition knowledge is expected to influence dietary behavior, the lack of a significant association may suggest that knowledge alone is insufficient to change eating habits in this population. This finding is not in line with previous studies in rural communities, which found that nutrition education improved knowledge of iron and iron-rich food intake practices among adolescents, but the impact on actual dietary behavior was limited (Wiafe et al., 2023). Similarly, research in Indonesia demonstrated that nutrition education based on the PRECEDE model increased ferritin levels in adolescent girls by improving knowledge, attitudes, and dietary behaviors (Khani Jeihooni et al., 2021).

The non-significant association between BMI and ferritin levels suggests that body mass alone does not reliably predict ferritin status, which aligns with prior research indicating that iron deficiency can occur regardless of weight status (Agarvas et al., 2025). Similarly, physical activity and hemoglobin levels were not significant predictors, indicating that ferritin provides a more direct and sensitive measure of iron reserves than hemoglobin alone (DePalma et al., 2021; Fite et al., 2022; Mei et al., 2021).

The importance of promoting healthy dietary patterns among adolescent girls to improve ferritin status. Interventions should focus not only on increasing awareness of nutrition but also on facilitating access to diverse, iron-rich foods and creating supportive environments for healthy eating. However, this study has several limitations, including its cross-sectional design, which prevents establishing causal relationships, and reliance on self-reported dietary data, which may be subject to recall bias. Additionally, the sample was limited to adolescent girls in a single district, which may reduce the generalizability of the findings to other populations. Despite these limitations, the study provides valuable insights into the role of dietary patterns in determining ferritin status and offers practical guidance for public health interventions.

4. CONCLUSION

In summary, this study found a significant association between dietary patterns and ferritin status among adolescent girls, while age, nutrition knowledge, body mass index, physical activity, and hemoglobin concentration were not significantly related to ferritin levels, suggesting that overall dietary quality may be more closely associated with iron stores in this population. These findings should be interpreted cautiously due to the cross-sectional design, modest sample size, reliance on self-reported dietary data, and the absence of key confounders such as inflammatory status, menstrual blood loss, parasitic infections, and socioeconomic factors. Nevertheless, the results underscore the importance of adolescent nutrition programs in Indonesia focusing on improving dietary quality, particularly the intake of iron-rich and iron-enhancing foods, through school-based nutrition education and supportive food environments. Future studies using longitudinal or intervention designs with larger samples and additional biological and contextual measures are needed to strengthen causal understanding and inform more targeted public health strategies.

REFERENCES

Abu-Baker, N. N., Eyadat, A. M., & Khamaiseh, A. M. (2021). The impact of nutrition education on knowledge, attitude, and practice regarding iron deficiency anemia among female adolescent students in Jordan. *Heliyon*, *7*(2), e06348. https://doi.org/10.1016/j.heliyon.2021.e06348

Agarvas, A. R., Sparla, R., Atkins, J. L., Altamura, C., Anderson, T., Asicioglu, E., ... & Muckenthaler, M. U. (2025). Ferritin and transferrin predict common carotid intima-media thickness in females: a machine-learning informed individual participant data meta-analysis. *MedRxiv*. https://doi.org/10.1101/2025.04.30.25326720

Ajetunmobi, O. A., & Laobangdisa, S. (2024). The Effect of Cultural and Socio-economics Factors on Consumer Perception. In *Consumer Perceptions and Food* (pp. 23–44). Springer Nature Singapore. https://doi.org/10.1007/978-981-97-7870-6_2

Ayal, B. G., Demilew, Y. M., Derseh, H. A., & Kidie, A. A. (2022). Micronutrient intake and associated factors among school adolescent girls in Meshenti Town, Bahir Dar City Administration, Northwest Ethiopia, 2020. *Plos One*, *17*(11), e0277263. https://doi.org/10.1371/journal.pone.0277263

Bennett, G., Bardon, L. A., & Gibney, E. R. (2022). A Comparison of Dietary Patterns and Factors Influencing Food Choice among Ethnic Groups Living in One Locality: A Systematic Review. *Nutrients*, *14*(5), 941. https://doi.org/10.3390/nu14050941

Cohen, C. T., & Powers, J. M. (2024). Nutritional Strategies for Managing Iron Deficiency in Adolescents: Approaches to a Challenging but Common Problem. *Advances in Nutrition*, *15*(5), 100215. https://doi.org/10.1016/j.advnut.2024.100215

Conrad, A., Burns, J., Sherburne, L., Kaled, M. D., Souley, H., & Nielsen, J. (2024). Understanding behavioural drivers of iron and folic acid supplementation and vitamin A- and iron-rich food consumption among women and adolescent girls in Niger. *Public Health Nutrition*, 27, e249. https://doi.org/10.1017/S1368980024002192

DePalma, R. G., Hayes, V. W., & O'Leary, T. J. (2021). Optimal serum ferritin level range: iron status measure and inflammatory biomarker. *Metallomics*, *13*(6). https://doi.org/10.1093/mtomcs/mfab030

English, L. K., Ard, J. D., Bailey, R. L., Bates, M., Bazzano, L. A., Boushey, C. J., ... & Heymsfield, S. B. (2021). Evaluation of dietary patterns and all-cause mortality: a systematic review. *JAMA network open*, 4(8), e2122277. https://doi.org/10.1001/jamanetworkopen.2021.22277

Fite, M. B., Bikila, D., Habtu, W., Tura, A. K., Yadeta, T. A., Oljira, L., & Roba, K. T. (2022). Beyond hemoglobin: uncovering iron deficiency and iron deficiency anemia using serum ferritin concentration among pregnant women in eastern Ethiopia: a community-based study. *BMC Nutrition*, *8*(1), 82. https://doi.org/10.1186/s40795-022-00579-8

Fu, J., Zeng, C., Huang, J., Guo, J., Su, Z., Luo, S., ... & Li, Y. (2024). Dietary patterns and association with Iron deficiency among children and adolescents aged 9–17 years in rural Guangzhou, China: a cross-sectional study. *Frontiers in Nutrition*, 11, 1443849. https://doi.org/10.3389/fnut.2024.1443849

Ge, S., Ali, S., Haldane, V., Bekdache, C., Tang, G. H., & Sholzberg, M. (2025). An approach to Hemequity: Identifying the barriers and facilitators of iron deficiency reduction strategies in low- to middle-income countries. *British Journal of Haematology*, 206(2), 428–442. https://doi.org/10.1111/bjh.19984

Gherasim, A., Arhire, L. I., Niţă, O., Popa, A. D., Graur, M., & Mihalache, L. (2020). The relationship between lifestyle components and dietary patterns. *Proceedings of the Nutrition Society*, *79*(3), 311–323. https://doi.org/10.1017/S0029665120006898

Hallström, E., Löfvenborg, J. E., Moreaus, L., Sjöberg, A., Winkvist, A., & Lindroos, A. K. (2025). Iron intake and iron status of Swedish adolescents with diets of varying climate impact. *European Journal of Nutrition*, 64(2), 93. https://doi.org/10.1007/s00394-024-03572-y

Hassan, F., Kalsoom, S., Sheikh, N. H., & Humayun, A. (2020). Factors affecting food consumption patterns and dietary practices of adolescent girls: an explanatory sequential mixed method study. *Annals of King Edward Medical University*, *26*(1), 9–18.

Islam, M., Trenholm, J., Rahman, A., Pervin, J., Ekström, E.-C., & Rahman, S. (2019). Sociocultural Influences on Dietary Practices and Physical Activity Behaviors of Rural Adolescents—A Qualitative Exploration. *Nutrients*, 11(12), 2916. https://doi.org/10.3390/nu11122916

Khani Jeihooni, A., Hoshyar, S., Afzali Harsini, P., & Rakhshani, T. (2021). The effect of nutrition education based on PRECEDE model on iron deficiency anemia among female students. *BMC Women's Health*, 21(1), 256. https://doi.org/10.1186/s12905-021-01394-2

Knijff, M., Roshita, A., Suryantan, J., Izwardy, D., & Rah, J. H. (2021). Frequent Consumption of Micronutrient-Rich Foods Is Associated With Reduced Risk of Anemia Among Adolescent Girls and Boys in Indonesia: A Cross-Sectional Study. *Food and Nutrition Bulletin*, *42*(1_suppl), S59–S71. https://doi.org/10.1177/0379572120977455

Kolarš, B., Mijatović Jovin, V., Živanović, N., Minaković, I., Gvozdenović, N., Dickov Kokeza, I., & Lesjak, M. (2025). Iron Deficiency and Iron Deficiency Anemia: A Comprehensive Overview of Established and Emerging Concepts. *Pharmaceuticals*, 18(8), 1104. https://doi.org/10.3390/ph18081104

Ma, J., Huang, J., Zeng, C., Zhong, X., Zhang, W., Zhang, B., & Li, Y. (2023). Dietary Patterns and Association with Anemia in Children Aged 9–16 Years in Guangzhou, China: A Cross-Sectional Study. *Nutrients*, 15(19), 4133. https://doi.org/10.3390/nu15194133

Mama Chabi, S., Fanou-Fogny, N., Nago Koukoubou, E., Deforche, B., & Van Lippevelde, W. (2022). Factors Explaining Adolescent Girls' Eating Habits in Urban Benin: A Qualitative Study. *Adolescents*, 2(2), 205–219. https://doi.org/10.3390/adolescents2020017

Mei, Z., Addo, O. Y., Jefferds, M. E., Sharma, A. J., Flores-Ayala, R. C., & Brittenham, G. M. (2021). Physiologically based serum ferritin thresholds for iron deficiency in children and non-pregnant women: a US National Health and Nutrition Examination Surveys (NHANES) serial cross-sectional study. *The Lancet Haematology*, 8(8), e572–e582. https://doi.org/10.1016/S2352-3026(21)00168-X

Obeagu, E. I. (2025). Iron homeostasis and health: understanding its role beyond blood health – a narrative review. *Annals of Medicine & Surgery*, *87*(6), 3362–3371. https://doi.org/10.1097/MS9.0000000000003100

Putri, F., Suyanto, S., Restila, R., Laksono, A. D., & Sundjaya, T. (2025). Exploring the role of nutritional status and anthropometric factors in anemia among adolescent girls in Pekanbaru, Indonesia. *SAGE Open Medicine*, 13, 1-10. https://doi.org/10.1177/20503121251355406

Samson, K. L. I., Fischer, J. A. J., & Roche, M. L. (2022). Iron Status, Anemia, and Iron Interventions and Their Associations with Cognitive and Academic Performance in Adolescents: A Systematic Review. *Nutrients*, 14(1), 224. https://doi.org/10.3390/nu14010224

Soans, J. S., Noronha, J. A., Mundkur, S. C., Nayak, B. S., Garg, M., Jathanna, R. D., & Mathias, E. G. (2025). Mapping evidence on the impact of junk food on anaemia among adolescent and adult population: a scoping review. *BMC Nutrition*, 11(1), 96. https://doi.org/10.1186/s40795-025-01079-1

Soliman, A. T., Alaaraj, N., Noor Hamed, Alyafei, F., Ahmed, S., Shaat, M., Itani, M., Elalaily, R., & Soliman, N. (2022). Review Nutritional interventions during adolescence and their possible effects. *Acta Bio-Medica : Atenei Parmensis*, 93(1), e2022087. https://doi.org/10.23750/abm.v93i1.12789

Stubbendorff, A., Borgström Bolmsjö, B., Bejersten, T., Warensjö Lemming, E., Calling, S., & Wolff, M. (2025). Iron insight: exploring dietary patterns and iron deficiency among teenage girls in Sweden. *European Journal of Nutrition*, *64*(3), 107. https://doi.org/10.1007/s00394-025-03630-z

Vajdi, M., & Farhangi, M. A. (2020). A systematic review of the association between dietary patterns and health-related quality of life. *Health and Quality of Life Outcomes*, *18*(1), 337. https://doi.org/10.1186/s12955-020-01581-z

Wiafe, M. A., Apprey, C., & Annan, R. A. (2023). Nutrition Education Improves Knowledge of Iron and Iron-Rich Food Intake Practices among Young Adolescents: A Nonrandomized Controlled Trial. *International Journal of Food Science*, 2023, 1–10. https://doi.org/10.1155/2023/1804763

World Health Organization. (2020). *WHO guideline on use of ferritin concentrations to assess iron status in populations*. World Health Organization.

Yunanci, S., Risma, R., Masrif, M., & Mulianingsih, M. (2023). A literature review of the relation between iron deficiency anaemia, physical activity and cognitive function in adolescent girls. *Scripta Medica*, 54(4), 405–412. https://doi.org/10.5937/scriptamed54-46534