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Genetic Factors Causing the Prevalence of Anemia in Young Girls and Stunting in Toddlers: A Systematic Literature Review

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Abstract: The prevalence of anemia in adolescents at the national level is still considered quite high. Several factors are associated with the incidence of anemia in female adolescents, namely energy intake, protein intake, iron intake, vitamin C intake, tea or coffee drinking habits, investment in worms, knowledge, education and type of parental occupation, family income, and menstrual patterns as well as genetics. Stunting is also still a problem in Indonesia due to insufficient nutritional intake for quite a long time. Stunting occurs when the fetus is still in the womb and only appears when the child is two years old. anemia caused by malnutrition at an early age increases infant and child mortality. anemia in young women and also stunting in children is very dangerous. Where the purpose of research is to explain Genetic Factors Causing the Prevalence of Anemia in Young Girls and Stunting in Toddlers. A review is conducted on the state-of-the-art methods using the preferred reporting items for reviews and meta-analyses (PRISMA) guidelines. We review literature from several publications and analyze genetic factors that cause the prevalence of anemia in young women. The prevalence of anemia among young women is also caused by genetic factors. Young women tend to experience anemia because during this period they experience growth and development. The risk of anemia increases with physiological shifts such as menstrual periods. To prevent anemia, the government has planned a program for the Prevention and Control of Iron Nutrition Anemia in women of childbearing age which aims to reduce the prevalence of iron deficiency anemia in high school and junior high school students.

Keywords: Anemia; Genetics; Stunting; Teenage girl

Introduction

Anemia is a medical condition in which the hemoglobin level is less than normal (Parodi et al., 2021). Normal Hb levels in female adolescents are >12 g/dl. Adolescent girls are said to be anemic if their Hb levels have become a public health problem that needs special attention (Sulistiyanti et al., 2022). The group that is at risk for anemia is adolescents because adolescents are experiencing growth and require a higher intake of nutrients. In addition, teenagers tend to spend time with peers outside the home so their food intake becomes unbalanced (Chortatos et al., 2018). The prevalence of anemia in adolescents at the national level is still considered quite high. Based on the trigger level of the Ministry of Health, the prevalence of anemia is a mild problem if it is at <20%, a moderate problem if it is at 20-39% and it is said to be a severe problem if it is at >40%.

Based on Basic Health Research data in 2007, the prevalence of anemia aged 5-14 years was 9.4%. This figure has increased based on the 2013 Riskesdas to 26.4%. Based on Riskesdas 2007 and 2013, an increase in

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the prevalence of anemia aged 15-24 years also occurred from 6.9% to 18.4%. If a person suffers from anemia since he was a teenager, it can result in growth and development disorders, decreased productivity, fatigue, and difficulty concentrating in learning, and at a later stage, it can affect children's intelligence and comprehension. In female adolescents, the menstrual cycle is a risk factor for anemia (Deivita et al., 2021). When one component of red blood cells is wasted. Adolescent girls who are menstruating on average lose iron in the blood of ±0.56 mg/day per menstrual cycle. Meanwhile, male adolescents may be at risk of developing anemia due to a lack of iron intake or the presence of an infectious disease (Kounnavong et al., 2020).

Several factors are associated with the incidence of anemia in female adolescents, namely energy intake, protein intake, iron intake, vitamin C intake, tea or coffee drinking habits, investment in worms, knowledge, education and type of parental occupation, family income, and menstrual patterns. (Fitrianti & Yunis Miko, 2019) Apart from the factors above, many conditions can cause a person to experience anemia, ranging from nutritional deficiencies to chronic diseases. However, some people are born with a genetic disorder that causes anemia. Genetic factors or hereditary factors are the basic concepts or capital for the continued development of the behavior of living things (Morgan & Rose, 2019). Anemia in adolescents is more common in girls because every month they experience menstruation (Novelia et al., 2022). This is a condition that can also be referred to as hemolytic anemia. This condition includes when the body's immune system destroys red blood cells on its own.

Anemia causes insufficient blood to bind and transport oxygen from the lungs throughout the body (Hanna-Rivero et al., 2022). If the oxygen needed is not enough, it will result in difficulty concentrating, low physical endurance, and decreased physical activity. To prevent anemia, the government has planned a program for the Prevention and Control of Iron Nutrition Anemia in women of childbearing age which aims to reduce the prevalence of iron deficiency anemia in high school and junior high school students. There are two main activities in this program, namely the provision of Education, Information, and Counseling such as counseling, promotion, campaigns about anemia, and routine administration of iron tablets.

As a national health problem, stunting needs special attention and treatment from various parties, starting from the government, down to the family level. Under these conditions, Budi Gunadi Sadikin as the Minister of Health of the Republic of Indonesia stated that there were 3 efforts to be made to prevent stunting which would start in a woman's pre-pregnancy period. In his statement at the Balanced Nutrition Campaign and MURI Record-breaking event which was held on Thursday 11 August 2022, Minister Budi Gunadi Sadikin said the Ministry of Health was tasked with reducing the stunting rate from 24% to 14% in 2024. For this reason, interventions will be focused on women before giving birth as a preventative measure. Pregnant women are closely related to the situation when they become young women. Genetic factors play an important role in terms of anemia that was brought at birth plus other external factors.

Not only occurs in young women, but anemia also occurs in pregnant women, which can inhibit fetal growth, premature birth, and childbirth with insufficient iron reserves, and anemia in pregnant women can cause complications, problems during childbirth, and can be dangerous to mother's condition such as fainting or even death. Growth stunting is one of the nutritional problems that arise in toddlers. Developmental delays in young children are the result of nutritional problems that arise from an early age. A nutrition journal shows that a history of anemia during pregnancy is a risk factor for stunting, plus genetic triggers from parents who have a history of anemia (Arinda et al., 2022).

Stunted children are children whose height does not match their age, as indicated by the results of the z-score for height for age, which is less than minus two SD (>-2SD). The prevalence of stunting begins to increase at the age of 3 months, then the stunting process slows down when the child is around 3 years old (Siddiqa et al., 2022). According to WHO, the causes of stunting in toddlers are maternal and environmental factors, inadequate food supplies, exclusive breastfeeding, and infection. (Veiga et al., 2023). Matters related to stunting according to WHO are social and community factors which are divided into political economy, health and health services, infrastructure and health service systems, education, social culture, agriculture, water and environmental sanitation. The high prevalence and the presence of several factors that affect anemia in young women and stunting in children are the background for researchers to examine The high prevalence and the presence of several factors that affect anemia in young women and stunting in children are the background for researchers to examine Genetic Factors Causing the Prevalence of Anemia in Young Girls and Stunting in Toddlers.

Method

We conducted this research as a systematic review by following the PRISMA guidelines. The PRISMA guidelines provide several items that need to be

considered in preparing a systematic review. In this study, we will mainly focus on several key items: Anemia, genetics, teenage girl, and stunting. This helps form the basis of our assessment. Initially, we collected the latest studies on Genetic Factors Causing the Prevalence of Anemia in Young Girls and Stunting in Toddlers, based on a few selected keywords. Then, we apply eligibility criteria to the collection. We only selected literature published in 2017 or later to provide an overview of recent trends. In addition, we limit the types of literature, namely only literature in the form of journals and proceedings.

Result and Discussion

Selected Reporting Items for Systematic Review (PRISMA) is the reporting technique used in this study. The research was carried out methodically during the necessary research phases. The information provided is comprehensive and impartial and aims to incorporate the results of relevant studies. The steps of a systematic literature review include developing research questions, searching the literature, screening and selecting relevant articles, screening and selecting the best research results, analyzing, synthesizing qualitative results, and preparing research reports. Writing the background and purpose of the study, collecting research questions, searching the literature, selecting articles, extracting articles, assessing the quality of the baseline study, and summarizing material are steps in the research process of a systematic literature review.

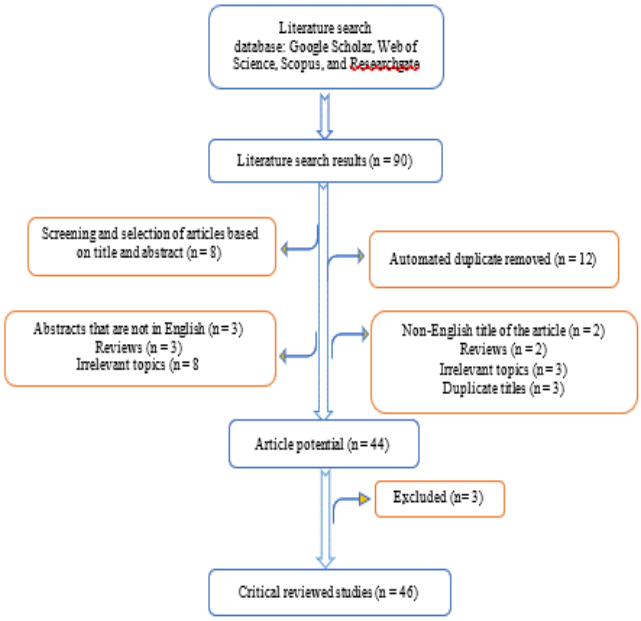

Figure 1. Flow process literature search based on PRISMA guidelines

Complete articles published in international journals from 2017-2023, indexed in databases, and themed Genetic Factors Causing the Prevalence of Anemia in Young Girls and Stunting in Toddlers.

Table 1. Prevalence of anemia

Source	Causes of Anemia
(Munro et al., 2023); (Kumar et al., 2022); (Safiri et al., 2021); (Gujo & Kare, 2021); (Sharma et al., 2021)	Direct Cause
(Chai et al., 2021); (Daru et al., 2018); (Andriastuti et al., 2020); (Kinyoki et al., 2021); (Nagao & Hirokawa, 2017); (Trudel et al., 2022); (Bryer & Henry, 2018); (Samohvalov & Samohvalov, 2018)	Indirect Cause

The prevalence of anemia where causes of anemia are divided into two parts, namely direct causes which are factors that directly affect hemoglobin levels in a person including: Menstruation experienced by young women every month is one of the causes of anemia; Inadequate food intake for the body This factor is related to food intake that enters the body. Such as iron deficiency anemia, which is a lack of iron intake during meals or slow or chronic blood loss; A lifestyle such as breakfast is very important for a teenager because with breakfast the energy and thinking patterns of a teenager are not disturbed; Infections and parasites that contribute to an increase in anemia are malaria, HIV infection, and worm infections. In the tropics, parasitic infections, especially hookworms, can cause a lot of blood loss, because hookworms suck blood.

Meanwhile, anemia with indirect causes is factor that do not directly affect hemoglobin levels in a person, including Knowledge level makes one's understanding of anemia and its causes and prevention better. Someone who has good knowledge will try to prevent anemia such as consuming foods that contain lots of iron to maintain hemoglobin levels in normal conditions. Socioeconomic related to the ability of a family to meet family food needs both in terms of quantity and quality. Families with a high economic level will easily provide food intake for their families with food that fulfills balanced nutrition, but it is a different matter if this problem is experienced by families with a low economy so that often the amount of food that is important while quality by meeting balanced nutritional needs is lacking attention.

Table 2. Prevalence of Anemia In Adolescents

Source	Prevention and Management of Anemia
(Chouraqui, 2022); (Rahfiludin et al., 2021); (Krämer et al., 2021); (Creed-Kanashiro et al., 2000)	Increase consumption of nutritious foods
(Wendt et al., 2019); (Wiafe et al., 2021)	Eat vegetables and fruits that contain lots of vitamin C
(Kaur et al., 2022); (Lamounier et al., 2010); (Kumari & Chauhan, 2022)	Food fortification

Prevention and management of anemia in adolescents in several ways, namely increasing consumption of nutritious foods, eating foods that contain lots of iron, from animal foods (meat, fish, chicken, liver, eggs) and plant foods (dark green vegetables, beans, tempeh); Eating vegetables and fruits that contain lots of vitamin C (katuk leaves, cassava leaves, spinach, guava, Ambon bananas, oranges) and regular iron supplementation for a certain period aims to increase hemoglobin levels; Fortification of foodstuffs, namely adding one or more nutrients to food to increase nutritional value; Nutrition education and counseling; Nutrition education and counseling is an educative approach to produce the individuals or communities needed to improve food and nutritional status.

Table 3. Prevalence of Anemia in Young Girls Based on Genetic Factors

Source	Types Of Anemia That Can Be Inherited Genetically
(Esposito et al., 2022); (Moreno et al., 2021); (Gerrard & Dawson, 2022); (Uusimaa et al., 2022)	Congenital Pernicious Anemia
(Pes & Dore, 2022); (Barrera-Reyes & Tejero, 2019); (Lee et al., 2018); (Geck et al., 2023)	G6PD deficiency
(Wu et al., 2021); (Zhou et al., 2023); (He et al., 2018); (Sahile Kebede et al., 2022)	Congenital Spherocytosis
(Esoh & Wonkam, 2021); (Cordovil, 2018)	Sickle Cell Anemia
(Origa, 2017); (Brancaleoni et al., 2016); (Ferih et al., 2023); (Ali Al-Barazanchi et al., 2021)	Thalassemia

Types of anemia that can be inherited genetically, namely Pernicious anemia: This is a rare type of anemia and is caused by abnormalities a person is born with, namely not having the ability to produce intrinsic factor (a protein in the stomach that helps the absorption of vitamin B12). Vitamin B12 plays a role in making red blood cells, without which the body does not have a sufficient number of new red blood cells. Vitamin B12 deficiency can cause complications, such as nerve damage, memory loss, and liver enlargement; glucose-6-phosphate dehydrogenase, namely anemia caused by the body not being able to produce enough Glucose-6-Phosphate Dehydrogenase (G6PD). The G6PD enzyme is an enzyme that functions to protect red blood cells from being destroyed by various drugs and chemicals; Congenital spherocytosis is a disease characterized by the formation of abnormal red blood cells called spherocytes. These red blood cells are very thin and fragile.

Spherocytes cannot change shape like red blood cells on their way to tissues, so they last longer in the spleen where they are destroyed. The destruction of the red blood cells eventually results in anemia; Sickle cell anemia has an inherited gene that causes hemoglobin to form abnormally. Normally, the shape of red blood cells is round and flexible, so they move easily in blood vessels. However, in people with sickle cell anemia, the red blood cells are sickle-shaped, stiff, and easily stick to small blood vessels. As a result, red blood cells cannot carry oxygen properly and break easily. Sickle cell anemia should not be underestimated, because it can put the sufferer at risk of having a stroke, heart attack, or swelling of the hands and feet, to decrease the body's ability to fight infection; Thalassemia is also a type of anemia that can be inherited genetically. This disease occurs when the body is unable to produce enough hemoglobin, which functions to carry oxygen throughout the body. Thalassemia that is still mild usually causes symptoms, such as symptoms of anemia in general, namely the body feels weak. However, when it is severe, thalassemia can interfere with growth, causing enlarged spleen, bone problems, and jaundice.

Table 4. Prevalence of Anemia in Stunted Children Based on Genetic Factors

Source	Efforts To Be Made To Prevent Stunting
(Sumual & Soputan, 2023)	Provision of TTD (Add Blood Tablets) for young women
(Sanghvi et al., 2022); (Kusumajaya et al., 2023); (Ciulei et al., 2023)	Conduct pregnancy checks and provide supplementary food to pregnant women to provide adequate nutrition and iron content in pregnant women
(Harrison et al., 2023); (Sjarif et al., 2019)	Provision of additional food in the form of animal protein to children aged 6-24 months such as eggs, fish, chicken, meat, and milk

The following are 3 efforts that will be carried out by public health in Indonesia to prevent stunting, including the Provision of Add Blood Tablets (ABT) for young women; Conducting pregnancy checks, and providing supplementary food to pregnant women to provide adequate nutrition and iron content in pregnant women; Provision of additional food in the form of animal protein to children aged 6-24 months such as eggs, fish, chicken, meat and milk. the three stunting prevention efforts mentioned above are urgent programs to implement. So that with these efforts, it is expected to be able to have a good impact on reducing stunting rates in Indonesia.

Conclusion

Several factors related to the incidence of anemia in female adolescents include energy intake, protein intake, iron intake, vitamin C intake, tea or coffee drinking habits, investment in worms, knowledge, education and type of work of parents, family income, and others. The prevalence of anemia in stunted children is also due to the factors above caused by genetic factors at the time. Adolescent girls tend to experience anemia because at this time they experience growth and development. The risk of anemia increases with physiological changes such as menstrual periods. Stunted children can also be affected by anemia during pregnancy. To prevent anemia, the government has planned a program for the Prevention and Control of Iron Nutrition Anemia in women of childbearing age which aims to reduce the prevalence of iron deficiency anemia in high school and junior high school students and will make efforts to prevent stunting in children. Indonesia.

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Conceptualization, Afrina Mizawati.; methodology, Afrina Mizawati; validation, Nursyirwan Effendi, Delmi Sulastri, and Rozi Sastra Purna. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

References

Ali Al-Barazanchi, Z., Abdulateef, S., & Hassan, M. (2021). Co-Inheritance of α-thalassemia gene mutation in patients with sickle cell Disease: Impact on clinical and hematological variables. *Nigerian Journal of Clinical Practice*, *24*(6), 874. https://doi.org/10.4103/njcp.njcp_11_20

Andriastuti, M., Ilmana, G., Nawangwulan, S. A., & Kosasih, K. A. (2020). Prevalence of anemia and iron profile among children and adolescents with low socio-economic status. *International Journal of Pediatrics and Adolescent Medicine*, *7*(2), 88–92. https://doi.org/10.1016/j.ijpam.2019.11.001

Arinda, I. K., Sserwanja, Q., Kamara, K., Mukunya, D., Agnes, N., Edirisa Juniour, N., Christinah, N., Kagali, A., & Lee, S. (2022). Anemia and Associated Factors Among Lactating Women in Sierra Leone: An Analysis of the Sierra Leone Demographic and Health Survey 2019. *Nutrition and Metabolic Insights*, *15*, 117863882211057. https://doi.org/10.1177/11786388221105732

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

Brancaleoni, V., Di Pierro, E., Motta, I., & Cappellini, M. D. (2016). Laboratory diagnosis of thalassemia. *International Journal of Laboratory Hematology*, *38*, 32–40. https://doi.org/10.1111/ijlh.12527

Bryer, E., & Henry, D. (2018). Chemotherapy-induced anemia: Etiology, pathophysiology, and implications for contemporary practice. *International Journal of Clinical Transfusion Medicine*, *Volume 6*, 21–31. https://doi.org/10.2147/IJCTM.S187569

Chai, A. L., Huang, O. Y., Rakočević, R., & Chung, P. (2021). Critical iron deficiency anemia with record low hemoglobin: A case report. *Journal of Medical Case Reports*, *15*(1), 472. https://doi.org/10.1186/s13256-021-03024-9

Chortatos, A., Terragni, L., Henjum, S., Gjertsen, M., Torheim, L. E., & Gebremariam, M. K. (2018). Consumption habits of school canteen and non-canteen users among Norwegian young adolescents: A mixed method analysis. *BMC Pediatrics*, *18*(1), 328. https://doi.org/10.1186/s12887-018-1299-0

Chouraqui, J.-P. (2022). Dietary Approaches to Iron Deficiency Prevention in Childhood—A Critical Public Health Issue. *Nutrients*, *14*(8), 1604. https://doi.org/10.3390/nu14081604

Ciulei, M. A., Smith, E. R., Perumal, N., Jakazi, C. S., Sudfeld, C. R., & Gernand, A. D. (2023). Nutritious Supplemental Foods for Pregnant Women from Food Insecure Settings: Types, Nutritional Composition, and Relationships to Health Outcomes. *Current Developments in Nutrition*, *7*(6),

100094. https://doi.org/10.1016/j.cdnut.2023.100094

Cordovil, K. (2018). *Sickle Cell Disease: A Genetic Disorder of Beta-Globin.* In Thalassemia and Other Hemolytic Anemias. InTech. https://doi.org/10.5772/intechopen.74778

Creed-Kanashiro, H. M., Uribe, T. G., Bartolini, R. M., Fukumoto, M. N., López, T. T., Zavaleta, N. M., & Bentley, M. E. (2000). Improving Dietary Intake to Prevent Anemia in Adolescent Girls through Community Kitchens in a Periurban Population of Lima, Peru. *The Journal of Nutrition*, *130*(2), 459S-461S. https://doi.org/10.1093/jn/130.2.459S

Daru, J., Zamora, J., Fernández-Félix, B. M., Vogel, J., Oladapo, O. T., Morisaki, N., Tunçalp, Ö., Torloni, M. R., Mittal, S., Jayaratne, K., Lumbiganon, P., Togoobaatar, G., Thangaratinam, S., & Khan, K. S. (2018). Risk of maternal mortality in women with severe anemia during pregnancy and postpartum: A multilevel analysis. *The Lancet Global Health*, *6*(5), e548–e554. https://doi.org/10.1016/S2214-109X(18)30078-0

Deivita, Y., Syafruddin, S., Andi Nilawati, U., Aminuddin, A., Burhanuddin, B., & Zahir, Z. (2021). Overview of Anemia; risk factors and solution offering. *Gaceta Sanitaria*, *35*, S235–S241. https://doi.org/10.1016/j.gaceta.2021.07.034

Esoh, K., & Wonkam, A. (2021). Evolutionary history of sickle-cell mutation: Implications for global genetic medicine. *Human Molecular Genetics*, *30*(R1), R119–R128. https://doi.org/10.1093/hmg/ddab004

Esposito, G., Dottori, L., Pivetta, G., Ligato, I., Dilaghi, E., & Lahner, E. (2022). Pernicious Anemia: The Hematological Presentation of a Multifaceted Disorder Caused by Cobalamin Deficiency. *Nutrients*, *14*(8), 1672. https://doi.org/10.3390/nu14081672

Ferih, K., Elsayed, B., Elshoeibi, A. M., Elsabagh, A. A., Elhadary, M., Soliman, A., Abdalgayoom, M., & Yassin, M. (2023). Applications of Artificial Intelligence in Thalassemia: A Comprehensive Review. *Diagnostics*, *13*(9), 1551. https://doi.org/10.3390/diagnostics13091551

Fitrianti, L., & Yunis Miko, T. (2019). Factors Associated with Anemia Among Adolescence Girls at SMAN 1 Telukjambe Kabupaten Karawang in 2015. *KnE Life Sciences*, *4*(10), 454. https://doi.org/10.18502/kls.v4i10.3751

Geck, R. C., Powell, N. R., & Dunham, M. J. (2023). Functional interpretation, cataloging, and analysis of 1,341 glucose-6-phosphate dehydrogenase variants. *The American Journal of Human Genetics*, *110*(2), 228–239. https://doi.org/10.1016/j.ajhg.2023.01.003

Gerrard, A., & Dawson, C. (2022). Homocystinuria diagnosis and management: It is not all classical. *Journal of Clinical Pathology*, *75*(11), 744–750. https://doi.org/10.1136/jcp-2021-208029

Gujo, A. B., & Kare, A. P. (2021). Prevalence of Intestinal Parasite Infection and its Association with Anemia among Children Aged 6 to 59 Months in Sidama National Regional State, Southern Ethiopia. *Clinical Medicine Insights: Pediatrics*, *15*, 117955652110292. https://doi.org/10.1177/11795565211029259

Hanna-Rivero, N., Tu, S. J., Elliott, A. D., Pitman, B. M., Gallagher, C., Lau, D. H., Sanders, P., & Wong, C. X. (2022). Anemia and iron deficiency in patients with atrial fibrillation. *BMC Cardiovascular Disorders*, *22*(1), 204. https://doi.org/10.1186/s12872-022-02633-6

Harrison, L., Padhani, Z., Salam, R., Oh, C., Rahim, K., Maqsood, M., Ali, A., Charbonneau, K., Keats, E. C., Lassi, Z. S., Imdad, A., Owais, A., Das, J., & Bhutta, Z. A. (2023). Dietary Strategies for Complementary Feeding between 6 and 24 Months of Age: The Evidence. *Nutrients*, *15*(13), 3041. https://doi.org/10.3390/nu15133041

He, B.-J., Liao, L., Deng, Z.-F., Tao, Y.-F., Xu, Y.-C., & Lin, F.-Q. (2018). Molecular Genetic Mechanisms of Hereditary Spherocytosis: Current Perspectives. *Acta Haematologica*, *139*(1), 60–66. https://doi.org/10.1159/000486229

Kaur, N., Agarwal, A., & Sabharwal, M. (2022). Food fortification strategies to deliver nutrients for the management of iron deficiency anemia. *Current Research in Food Science*, *5*, 2094–2107. https://doi.org/10.1016/j.crfs.2022.10.020

Kinyoki, D., Osgood-Zimmerman, A. E., Bhattacharjee, N. V., Local Burden of Disease Anaemia Collaborators, Schaeffer, L. E., Lazzar-Atwood, A., Lu, D., Ewald, S. B., Donkers, K. M., Letourneau, I. D., Collison, M., Schipp, M. F., Abajobir, A., Abbasi, S., Abbasi, N., Abbasifard, M., Abbasi-Kangevari, M., Abbastabar, H., Abd-Allah, F., … Hay, S. I. (2021). Anemia prevalence in women of reproductive age in low- and middle-income countries between 2000 and 2018. *Nature Medicine*, *27*(10), 1761–1782. https://doi.org/10.1038/s41591-021-01498-0

Kounnavong, S., Vonglokham, M., Kounnavong, T., Kwadwo, D. D., & Essink, D. R. (2020). Anemia among adolescents: Assessing a public health concern in Lao PDR. *Global Health Action*, *13*(sup2), 1786997. https://doi.org/10.1080/16549716.2020.1786997

Krämer, M., Kumar, S., & Vollmer, S. (2021). Anemia, diet, and cognitive development: Impact of health information on diet quality and child nutrition in rural India. *Journal of Economic Behavior &*

Organization, *190*, 495–523. https://doi.org/10.1016/j.jebo.2021.06.043

Kumar, A., Sharma, E., Marley, A., Samaan, M. A., & Brookes, M. J. (2022). Iron deficiency anemia: Pathophysiology, assessment, practical management. *BMJ Open Gastroenterology*, *9*(1), e000759. https://doi.org/10.1136/bmjgast-2021-000759

Kumari, A., & Chauhan, A. K. (2022). Iron nanoparticles as a promising compound for food fortification in iron deficiency anemia: A review. *Journal of Food Science and Technology*, *59*(9), 3319–3335. https://doi.org/10.1007/s13197-021-05184-4

Kusumajaya, A. A. N., Mubasyiroh, R., Sudikno, S., Nainggolan, O., Nursanyoto, H., Sutiari, N. K., Adhi, K. T., Suarjana, I. M., & Januraga, P. P. (2023). Sociodemographic and Healthcare Factors Associated with Stunting in Children Aged 6–59 Months in the Urban Area of Bali Province, Indonesia 2018. *Nutrients*, *15*(2), 389. https://doi.org/10.3390/nu15020389

Lamounier, J. A., Capanema, F. D., Da Silva Rocha, D., De Oliveira, J. E. D., Costa Da Silva, M., & De Almeida, C. A. N. (2010). Iron Fortification Strategies for the Control of Childhood Anemia in Brazil. *Journal of Tropical Pediatrics*, *56*(6), 448–451. https://doi.org/10.1093/tropej/fmq001

Lee, J., Kim, T. I., Kang, J.-M., Jun, H., Lê, H. G., Thái, T. L., Sohn, W.-M., Myint, M. K., Lin, K., Kim, T.-S., & Na, B.-K. (2018). Prevalence of glucose-6-phosphate dehydrogenase (G6PD) deficiency among malaria patients in Upper Myanmar. *BMC Infectious Diseases*, *18*(1), 131. https://doi.org/10.1186/s12879-018-3031-y

Moreno, O., Paredes, A., Suarez-Obando, F., & Rojas, A. (2021). An update on Fanconi anemia: Clinical, cytogenetic and molecular approaches (Review). *Biomedical Reports*, *15*(3), 74. https://doi.org/10.3892/br.2021.1450

Morgan, I. G., & Rose, K. A. (2019). Myopia: Is the nature-nurture debate finally over? *Clinical and Experimental Optometry*, *102*(1), 3–17. https://doi.org/10.1111/cxo.12845

Munro, M. G., Mast, A. E., Powers, J. M., Kouides, P. A., O'Brien, S. H., Richards, T., Lavin, M., & Levy, B. S. (2023). The relationship between heavy menstrual bleeding, iron deficiency, and iron deficiency anemia. *American Journal of Obstetrics and Gynecology*, *229*(1), 1–9. https://doi.org/10.1016/j.ajog.2023.01.017

Nagao, T., & Hirokawa, M. (2017). Diagnosis and treatment of macrocytic anemias in adults. *Journal of General and Family Medicine*, *18*(5), 200–204. https://doi.org/10.1002/jgf2.31

Novelia, S., Rukmaini, & Purnama Sari, I. (2022). THE Analysis of Factors Associated with Anemia Among Adolescent Girls. *Nursing and Health Sciences Journal (NHSJ)*, *2*(3), 266–273. https://doi.org/10.53713/nhs.v2i3.142

Origa, R. (2017). β-Thalassemia. *Genetics in Medicine*, *19*(6), 609–619. https://doi.org/10.1038/gim.2016.173

Parodi, E., Riboldi, L., & Ramenghi, U. (2021). Hemoglobin life-threatening value (1.9 g/dl) in good general condition: A pediatric case report. *Italian Journal of Pediatrics*, *47*(1), 200. https://doi.org/10.1186/s13052-021-01146-w

Pes, G. M., & Dore, M. P. (2022). Acquired Glucose-6-Phosphate Dehydrogenase Deficiency. *Journal of Clinical Medicine*, *11*(22), 6689. https://doi.org/10.3390/jcm11226689

Rahfiludin, M. Z., Arso, S. P., Joko, T., Asna, A. F., Murwani, R., & Hidayanti, L. (2021). Plant-based Diet and Iron Deficiency Anemia in Sundanese Adolescent Girls at Islamic Boarding Schools in Indonesia. *Journal of Nutrition and Metabolism*, *2021*, 1–7. https://doi.org/10.1155/2021/6469883

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., & Grieger, J. A. (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

Sahile Kebede, S., Yalew, A., Yesuf, T., Mesfin Bambo, G., Duguma, T., & Woldu, B. (2022). The Magnitude of Hereditary Spherocytosis Among Human Immunodeficiency Virus-Infected Adults Attending University of Gondar Comprehensive Specialized Hospital Northwest Ethiopia 2021 GC, Cross-Sectional Study Design. *Pathology and Laboratory Medicine International*, *14*, 15–23. https://doi.org/10.2147/PLMI.S366451

Samohvalov, E., & Samohvalov, S. (2018). *The Pattern of Anemia in Lupus*. In Current Topics in Anemia. InTech. https://doi.org/10.5772/intechopen.71293

Sanghvi, T., Nguyen, P. H., Ghosh, S., Zafimanjaka, M., Walissa, T., Karama, R., Mahmud, Z., Tharaney, M., Escobar-Alegria, J., Dhuse, E. L., & Kim, S. S. (2022). Process of developing models of maternal nutrition interventions integrated into antenatal care services in Bangladesh, Burkina Faso, Ethiopia, and India. *Maternal & Child Nutrition*, *18*(4). https://doi.org/10.1111/mcn.13379

Sharma, Y. P., Kaur, N., Kasinadhuni, G., Batta, A., Chhabra, P., Verma, S., & Panda, P. (2021). Anemia in heart failure: Still an unsolved enigma. *The*

Egyptian Heart Journal, *73*(1), 75. https://doi.org/10.1186/s43044-021-00200-6

Siddiqa, M., Zubair, A., Kamal, A., Ijaz, M., & Abushal, T. (2022). Prevalence and associated factors of stunting, wasting, and underweight of children below five using quintile regression analysis (PDHS 2017–2018). *Scientific Reports*, *12*(1), 20326. https://doi.org/10.1038/s41598-022-24063-2

Sjarif, D. R., Yuliarti, K., & Iskandar, W. J. (2019). Daily consumption of growing-up milk is associated with less stunting among Indonesian toddlers. *Medical Journal of Indonesia*, *28*(1), 70–76. https://doi.org/10.13181/mji.v28i1.2607

Sulistiyanti, A., Ayu, S. M., Widiastuti, Y. P., & Nunes, C. F. D. C. (2022). Effectiveness of Nutrition Education on Anemia on the Level of Knowledge in Adolescents Girls. *Proceedings of the International Conference on Nursing and Health Sciences*, *3*(1), 131–138. https://doi.org/10.37287/picnhs.v3i1.1138

Sumual, H., & Soputan, G. J. (2023). The Role of Adolescents in Stunting Prevention in the Digital Era. *International Journal of Information Technology and Education, 2*(2), 19-25. Retrieved from https://www.ijite.jredu.id/index.php/ijite/article/view/106

Trudel, G., Shahin, N., Ramsay, T., Laneuville, O., & Louati, H. (2022). Hemolysis contributes to anemia during long-duration space flight. *Nature Medicine*, *28*(1), 59–62. https://doi.org/10.1038/s41591-021-01637-7

Uusimaa, J., Kettunen, J., Varilo, T., Järvelä, I., Kallijärvi, J., Kääriäinen, H., Laine, M., Lapatto, R., Myllynen, P., Niinikoski, H., Rahikkala, E., Suomalainen, A., Tikkanen, R., Tyynismaa, H., Vieira, P., Zarybnicky, T., Sipilä, P., Kuure, S., & Hinttala, R. (2022). The Finnish genetic heritage in 2022 – from diagnosis to translational research. *Disease Models & Mechanisms*, *15*(10), dmm049490. https://doi.org/10.1242/dmm.049490

Veiga, G. R. S., Da Silva, G. A. P., Padilha, B. M., & Lima, M. D. C. (2023). Determining factors of child linear growth from the viewpoint of Bronfenbrenner's Bioecological Theory. *Jornal de Pediatria*, *99*(3), 205–218. https://doi.org/10.1016/j.jped.2022.10.009

Wendt, A. S., Waid, J. L., & Gabrysch, S. (2019). Dietary Factors Moderate the Relation between Groundwater Iron and Anemia in Women and Children in Rural Bangladesh. *Current Developments in Nutrition*, *3*(10), nzz093. https://doi.org/10.1093/cdn/nzz093

Wiafe, M. A., Apprey, C., & Annan, R. A. (2021). Knowledge and practices of dietary iron and anemia among early adolescents in a rural district in Ghana. *Food Science & Nutrition*, *9*(6), 2915–2924. https://doi.org/10.1002/fsn3.2249

Wu, Y., Liao, L., & Lin, F. (2021). The diagnostic protocol for hereditary spherocytosis-2021 update. *Journal of Clinical Laboratory Analysis*, *35*(12). https://doi.org/10.1002/jcla.24034

Zhou, J., Zhang, H., Qin, Y., & Liu, T. (2023). Severe Microcytic Anemia Caused by Complex Hereditary Spherocytosis and X-Linked Sideroblastic Anemia with Mutations in SPTB and ALAS2 Genes. *Journal of Clinical Medicine*, *12*(5), 1990. https://doi.org/10.3390/jcm12051990