Correlation Mineral Water Consumption and Hemoglobin Levels in Adolescent Girls

Gela Setya Ayu Putri[*], Nurul Maolida, Andri Sukeksi
Faculty of Nursing and Health Sciences, Universitas Muhammadiyah Semarang, Semarang, Indonesia

ARTICLE INFO

ABSTRACT

Anemia is a global health issue that affects people of all ages, particularly adolescent girls. Adolescent girls require nutritional intake, both from food and water. According to the balanced nutrition guidelines, people (particularly adolescents and adults) require 2000 liters (or eight glasses) of water daily. Most adolescent girls barely consider their water consumption. A lack of water in the body affects the balance of minerals (salt and sugar), disrupting regular metabolic processes such as hemoglobin (Hb) level regulation. This study investigates the correlation between adolescent girls' water consumption and hemoglobin levels. This quantitative study uses a cross-sectional design to collect variable data at a certain time. The study used blood with anti-coagulants EDTA from 30 adolescent girls from Universitas Muhammadiyah Semarang. The primary data for this study are water consumption and hemoglobin levels. Results of the research show that adolescent girls' water consumption was adequate (66.7%) and low (33.3%). The average Hb level among adolescent girls was 12.4 g/dL. Adequate water consumption resulted in 3 respondents with low Hb levels and 7 with normal Hb levels. In contrast, low water consumption resulted in 2 respondents with low Hb levels and 18 with normal Hb levels. The Rank-Spearman correlation test showed sig 0.177 ($p>0.05$). The study concluded that there was no correlation between adolescent girl water consumption and hemoglobin levels. Food fluid intake can compensate for a lack of water consumption.

Corresponding author:

Gela Setya Ayu Putri
Faculty of Nursing and Health Sciences, Universitas Muhammadiyah Semarang, Semarang, Indonesia
Email: gela@unimus.ac.id

INTRODUCTION

Anemia is an illness that affects people worldwide. Over 1.62 billion individuals worldwide are affected by anemia. Anemia can affect people of many ages and backgrounds, including children, adolescents, pregnant women, and adults (Bhandari et al., 2021). Indonesia has a relatively high prevalence of anemia, with 26.4% of children aged 5 to 17 and 20.4% of adolescent aged 18 to 25. Adolescent girls had a higher frequency of anemia (23.9%) than adolescent boys (18.4%). Anemia in adolescent girls can be caused by a variety of causes, including menstruation and specific eating habits that result in insufficient. Adolescents require enough dietary intake to promote growth and development. Human nutrition comes from both food and water. According to the balanced nutrition guidelines, humans (particularly adolescents and adults) require 2000 liters or eight glasses of water daily (Sari et al., 2022).

According to a study on mineral water intake among teens in metropolitan Bogor, 24.1% of adolescent consume less than 90% of their mineral water requirements, and 37.3% drink less than eight glasses of water each day (Buanasita et al., 2015). The absence of mineral water intake in adolescents is caused by a lack of frequency of consumption and the existence of other drinks consumed, such as fruit juice, coffee, and other instant beverages (Briawan et al., 2011).

More than two-thirds of the body's composition is water. Body fluids help provide nutrients, maintain appropriate body temperature, blood flow, and pressure, neutralize toxins and filth, and promote healthy skin. Suppose the body's water level is low. In that case, the balance of minerals (salt and sugar) in the body is disrupted, causing the body's regular functions to fail, mainly kidney function (Suban et al., 2024).

The kidneys secrete the hormone renin, which plays an essential role in regulating blood pressure (renin angiotensin aldosterone system), and fibroblast cells produce the hormone

erythropoietin and stimulate the spinal cord to produce more red blood cells (erythrocytes). A lack of water in the kidneys can disrupt the process of filtration, reabsorption, and excretion of water and electrolytes from the body. The kidneys will attempt to maintain bodily fluids by decreasing urine output and boosting water reabsorption in the renal tubules (Anggraeny et al., 2021). Damaged kidneys will cause disease and a lack of red blood cells because the kidneys' production of the hormone erythropoietin is interrupted, decreasing hemoglobin levels in the blood (Amudi & Palar, 2021).

Hemoglobin, a protein that binds iron (Fe^{2+}), is a significant component of erythrocytes, which attempt to change O_2 and CO_2 and give blood its red hue. Each heme that binds to oxygen is called oxyhemoglobin (HbO_2). In saturated conditions, one gram of hemoglobin may bind 1.34 milliliters of oxygen (Ahmed et al., 2020). Average hemoglobin levels in males and women are different. The average hemoglobin level in men is 13-18gr/dL, whereas in women, it is 12-16gr/dL (Sari et al., 2022).

According to a research survey conducted at Universitas Muhammdiyah Semarang, most adolescent girls barely consider their water consumption. This author's background investigates the correlation between water consumption and hemoglobin levels in adolescent girls at Muhammdiyah University in Semarang.

METHOD

The research was quantitative with a cross-sectional design. The study used EDTA blood from 30 healthy adolescent girls from Universitas Muhammadiyah Semarang. The primary data for this study are water consumption and hemoglobin levels. Data on water consumption levels was obtained from the questionnaire. Water consumption levels are scored as follows: a) Low: an average of £ 8 glasses per week; b) Adequate: an average ≥8 glasses daily.

The research was conducted at the Hematology Laboratory, Muhammadiyah University, Semarang, in October 2023. Sampling was done using a purposive sampling technique to obtain samples from a population that met the inclusion and exclusion criteria. There were 30 respondents in this study.

Respondents who were menstruating and consumed iron tablets were excluded from the sample collection. Venous blood was collected in an EDTA tube. Hemoglobin levels were measured in venous EDTA blood samples using a Mindray BC-2800 hematology analyzer in the hematology laboratory at Universitas Muhammadiyah Semarang. The data collected was analyzed using the Spearman Rank correlation test.

All research protocols were approved by the Bioethics Commission for Medical or Health Research, Faculty of Medicine, Universitas Islam Sultan Agung, Semarang, Indonesia (certificate approval number 83/II/2024/Komisi Bioetik).

RESULTS

Table 1. Respondent characteristics

Characteristics	f	%
Gender		
Male	0	0
Women	30	100
Age		
Adolescent (17-25 years)	30	100
Adults (26-45 years)	0	0
Consume green vegetables		
Yes	17	56,7
No	13	43,3
Consume iced tea or coffee		
Yes	9	30
No	21	70
Consume fruit juice		
Yes	16	53,3
No	14	46,7

The majority of respondents in this study were adolescents aged 17 to 25. Some respondents consumed green vegetables, fruit juice, iced tea, and coffee. Before drawing blood, respondents filled out a questionnaire.

Table 2. Distribution of water consumption levels among adolescent girls

Water consumption level	f	%
Low	10	33.3
Adequate	20	66.7
Total	30	100

Table 2 shows that 66.7% of adolescent girls out of 30 sample respondents consumed adequate water.

Table 3. Frequency distribution of hemoglobin levels in adolescent girls

Variable	Average (g/dL)	Min (g/dL)	Max (g/dL)	SD
Hemoglobin level	12.4	11.2	13.4	0.06

Table 3 shows that the average hemoglobin level in adolescent girls from 30 sample respondents was 12.4g/dL in the normal category.

Table 4. Hemoglobin levels based on water consumption level

Water consumption levels	Hemoglobin Levels						Total
	Low		Normal		High		
	n	%	n	%	n	%	
Low	3	60	7	28	0	0	**10**
Adequate	2	40	18	72	0	0	**20**
Total	**5**	**100**	**25**	**100**	**0**	**0**	**30**

Table 4 shows that three respondents who consumed less water had low hemoglobin levels, while seven had normal levels. Meanwhile, two respondents who consumed adequate water had low hemoglobin levels, while 18 had normal levels. Various factors, including an unhealthy lifestyle, can influence this. The data was analyzed with Rank-Spearman.

Table 5. Correlation test results

Variable	p-value
Level of water consumption-hemoglobin level	0.177

Based on Table 5, the results of the Spearman rank test analysis show a p-value=0.177 (p-value>0.05), which means there is no significant correlation between the level of water consumption and hemoglobin levels in adolescent girls.

DISCUSSION

The results of measuring the hemoglobin of adolescent girls showed that the average hemoglobin level was normal, 12.4 g/dL. Hemoglobin is a pigment that contains much iron. Blood hemoglobin is influenced by several factors, one of which is diet. Consuming foods and drinks that contain iron, such as green vegetables, whole grains, offal, fruit, and others, can increase blood cell production, causing hemoglobin levels to increase (Nidianti et al., 2019).

The Spearman rank test results obtained a p-value of 0.177>0.05, indicating no significant relationship between water intake and hemoglobin levels in adolescent girls. A person who consumes adequate water does not cause a significant increase in hemoglobin levels. These results contradict Danziger et al. (2021), who indicate that adequate water consumption helps increase hemoglobin and oxygen contributes to hemoglobin production. The human body's fluid needs are typically contents for three sources: drink, food, and metabolism. Water is formed as a result of food metabolism. Food fluids can also help to replace lost body fluids. Drinking water and other beverages contribute to 70 to 80% of total fluid intake, whereas water from food constitutes 20 to 30%.

Respondents with low water consumption levels had mostly average hemoglobin levels. According to the questionnaire results, respondents had adequate iron in their bodies; thus, the food they consumed met the lack of fluid intake. Respondents who consumed little water were found to have low hemoglobin levels; this is influenced by kidney function; when the kidneys do not consume adequate water, the kidney system is disrupted, which can affect the production of the hormone erythropoietin in the kidneys, which is directly related to hemoglobin production (Badura et al., 2024).

The group of responders who fully met their water intake demands had low hemoglobin levels, although the decrease in hemoglobin levels in the sample was not statistically significant. Aside from hydration and food intake, other factors can influence hemoglobin levels in adolescent girls, including physical activity, a history of illnesses, and sleep patterns. Hemoglobin is an iron-rich pigment (Akhdiyat, 2020). Hemoglobin helps to keep blood cells in form and binds the oxygen we breathe. If hemoglobin levels are abnormal, red blood circulation will be impaired. A lack of iron in the blood is the cause of anemia. A person with low hemoglobin levels will feel extremely weary because a person with low hemoglobin levels will become exhausted immediately. After all, they do not receive enough oxygen to carry out activities (Bazeley and Wish, 2019). A person who sleeps later at night will have lower hemoglobin levels due to more interrupted functioning. Sleep is essential for forming new body cells, healing damaged cells, and maintaining metabolic equilibrium in the body (Neumann et al., 2020).

Hemoglobin levels are more influenced by factors such as iron intake, vitamins, B12, folate, and general health conditions. Iron is the main component in hemoglobin, and iron deficiency can cause anemia, a condition where hemoglobin levels in the blood become low. It is essential to ensure adequate iron intake through food or supplements, especially for individuals at risk of iron deficiency (Ye and Du, 2022).

CONCLUSION

The study concluded that there is no correlation between water consumption and hemoglobin levels in adolescent girls. Adolescent girls should continue consuming enough water and eating iron-rich foods to maintain hemoglobin levels.

REFERENCES

Ahmed, M. H., Ghatge, M. S., & Safo, M. K. (2020). Hemoglobin: Structure, Function, and Allostery. *Sub-cellular biochemistry, 94*, 345–382. https://doi.org/10.1007/978-3-030-41769-7_14

Akhdiyat, H. R. (2020). Analisis Kadar Hemoglobin Pada Pasien Penderita Gagal Ginjal KroNIK. *International Journal of Applied Chemistry Research, 1*(1), 1–5. https://doi.org/10.23887/ijacr.v1i1.28708

Amudi, T., & Palar, S. (2021). Gagal Ginjal Kronik Hemodialisis dengan Kadar Eritropoietin dan Hemoglobin Normal: Laporan Kasus. *Medical Scope Journal, 2*(2). https://doi.org/10.35790/msj.v2i2.32547

Anggraeny, S. F., Soebhali, B., Sulistiawati, S., Nasution, P. D. S., & Sawitri, E. (2021). Gambaran Status Konsumsi Air Minum Pada Pasien Batu Saluran Kemih. *Jurnal Sains dan Kesehatan, 3*(1):58–62. https://doi.org/10.25026/jsk.v3i1.211

Badura, K., Janc, J., Wąsik, J., Gnitecki, S., Skwira, S., Młynarska, E., Rysz, J., & Franczyk, B. (2024). Anemia of Chronic Kidney Disease-A Narrative Review of Its Pathophysiology, Diagnosis, and Management. *Biomedicines, 12*(6), 1191. https://doi.org/10.3390/biomedicines12061191

Bazeley, J., & Wish, J. B. (2019). The Evolution of Target Hemoglobin Levels in Anemia of Chronic Kidney Disease. *Advances in chronic kidney disease, 26*(4): 229–236. https://doi.org/10.1053/j.ackd.2019.06.001

Bhandari, B., Kachapati, A., Lamichhane, K., & Khadka, G. (2021). Anemia among Adolescent Girls Attending the Pediatric Outpatient Department of a Tertiary Care Hospital: A Descriptive Cross-sectional Study. JNMA: *Journal of the Nepal Medical Association, 59*(241): 862–866. https://doi.org/10.31729/jnma.6897

Briawan, Dodik., Arumsari, E., & Pusporini, P. (2011). Faktor Resiko Anemia Pada Mahasiswa Peserta Program Suplementasi. *Jurnal Nutrisi dan Pangan, 6*(1):74-83. https://doi.org/10.25182/jgp.2011.6.1.74-83

Buanasita, A., Andriyanto, A., Sulistyowati, I. Perbedaan Tingkat Konsumsi Energi, Lemak, Cairan, dan Status Hidrasi Mahasiswa Obesitas dan Non Obesitas. *Indonesian Journal of Human Nutrition, 2*(1), 11 – 22.

Danziger, J., Mukamal, K. J., & Weinhandl, E. (2021). Associations of Community Water Lead Concentrations with Hemoglobin Concentrations and Erythropoietin-Stimulating Agent Use among Patients with Advanced CKD. *Journal of the American Society of Nephrology: JASN, 32*(10), 2425–2434. https://doi.org/10.1681/ASN.2020091281

Neumann, S. N., Li, J. J., Yuan, X. D., Chen, S. H., Ma, C. R., Murray-Kolb, L. E., Shen, Y., Wu, S. L., & Gao, X. (2020). Anemia and insomnia: a cross-sectional study and meta-analysis. *Chinese Medical Journal, 134*(6): 675–681. https://doi.org/10.1097/CM9.0000000000001306

Nidianti, E., Nugraha, G., Aulia, I. A. N., Syadzila, S. K., Suciati, S. S., & Utami, N. D. (2019). Pemeriksaan Kadar Hemoglobin dengan Metode POCT (Point of Care Testing) sebagai Deteksi Dini Penyakit Anemia Bagi Masyarakat Desa Sumbersono, Mojokerto. *Jurnal Surya Masyarakat, 2*(1), 29-34. https://doi.org/10.26714/jsm.2.1.2019.29-34

Sari, P., Judistiani, R. T. D., Herawati, D. M. D., Dhamayanti, M., & Hilmanto, D. (2022). Iron Deficiency Anemia and Associated Factors Among Adolescent Girls and Women in a Rural Area of Jatinangor, Indonesia. *International Journal of Women's Health*, 1137-1147. https://doi.org/10.2147/IJWH.S376023

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

Suban, C., & Widani, N. L. (2024). Hubungan Konsumsi Air Minum terhadap Kejadian Gagal Ginjal Kronik Pasien Dengan Hemodialisis. *Jurnal Keperawatan Cikini, 5*(1):110-119. https://doi.org/10.55644/jkc.v5i01.146

Ye, T., & Du, K. (2022). Hemoglobin Level at Admission Is Less Important. *Critical care medicine, 50*(2): e214–e215. https://doi.org/10.1097/CCM.0000000000005323