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RESEARCH ARTICLE

Association Between Coffee Consumption Patterns and Hemoglobin Levels in Female Medical Students of UMSU Medical Faculty

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Introduction: Anemia remains a pervasive global public health issue, particularly among women of reproductive age. In Indonesia, the prevalence of anemia in young women is exacerbated by dietary habits that inhibit iron absorption. This study aims to determine the association between coffee consumption patterns and hemoglobin levels among female medical students at the Faculty of Medicine, Muhammadiyah University of North Sumatra (UMSU). **Method:** An analytical observational study utilizing a cross-sectional design was conducted with 84 female students selected via consecutive sampling. Coffee consumption patterns were assessed using a Food Frequency Questionnaire (FFQ), categorized into infrequent (<3x/week) and frequent (≥3x/week) intake. Hemoglobin levels were measured quantitatively. Data were analyzed using the Mann-Whitney U test to compare median hemoglobin levels between the two groups. **Results:** The cohort was dominated by 20-year-old students (34.5%). A significant majority exhibited frequent coffee consumption patterns (86.9%, n=72) compared to infrequent consumers (13.1%, n=12). The median hemoglobin level across the sample was 11.35 g/dL. Statistical analysis revealed a significant difference in hemoglobin levels between the frequent and infrequent coffee consumption groups ($p < 0.01$). **Conclusion:** There is a statistically significant association between high-frequency coffee consumption and lower hemoglobin levels among female medical students. These findings highlight the need for nutritional education regarding the timing of caffeine intake to mitigate the risk of anemia

Keywords: Anemia, Coffee, Hemoglobin

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INTRODUCTION

Anemia is one of the public health problems that has not been solved almost all over the world, both in developed and developing countries. According to WHO in 2019 the prevalence of anemia in women is 29.9% at the age of 15-49 years. The world's population that experiences anemia is around 30% or 2.20 billion people with most of them living in tropical areas. According to Riskesdas in 2018 anemia in Indonesia is recorded at 26.8% at the age of 5-14 years and around 32% at the age of 15-24 years. There are several factors related to anemia, namely protein intake, energy intake, vitamin C intake, as well as tea and coffee drinking habits, as well as menstrual patterns. Hemoglobin levels in women are said to be normal if hemoglobin is >12 g/dl. It is said to be low if <12 g/dl. If hemoglobin levels in women are low, it will increase the risk of anemia.[1]

Heme protein derived from red blood cells, hemoglobin controls the body's oxygen and carbon dioxide exchange mechanisms. Iron is abundant in hemoglobin, a protein. Blood tests can detect anemia in a population by measuring hemoglobin levels. Every living organism has hemoglobin, a protein in red blood cells that carries oxygen and iron. Due to its ability to combine oxygen, hemoglobin can be converted into oxygenhemoglobin in red blood cells. Subsequent oxygen transport to the tissues occurs in the lungs. Chemical measurements of hemoglobin can be used as an indicator of the blood's ability to carry oxygen, as can the amount of hemoglobin per 100 milliliters of blood. An indicator of respiratory pigmentation of red blood cells is hemoglobin levels. Typically, "100%" refers to the proportion of hemoglobin in normal blood, which is about 15 grams per 100 milliliters.[2]

The main function of red blood cells is to transport oxygen from the bloodstream to the tissues of the body. Erythrocytes transport oxygen and carbon dioxide through their main component, hemoglobin. Hemoglobin transports oxygen from the lungs to the rest of the body for energy, helps remove carbon dioxide, and exchanges carbon and oxygen, according to Indonesia's Ministry of Health by Widayanti.[3]

Anemia can cause blood to be unable to bind and transport enough oxygen from the lungs to the rest of the body. If the oxygen needed is not enough, it will cause difficulty concentrating, decreased memory and activity, and low immunity. One of the causes of decreased hemoglobin levels is eating foods that are low in iron sources, other causes can also be due to low iron absorption in the intestines due to eating foods that can inhibit iron absorption. For example, consuming phytate and caffeine.[4] If you consume too much caffeine, it will result in a decrease in hemoglobin levels in the body because it inhibits iron absorption. This increase in caffeine consumption is often not followed by knowledge about the impact that will occur if you consume too much caffeine.[5]

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Based on data from the Ministry of Industry of the Republic of Indonesia in 2016, the number of national coffee consumption of the Indonesian people in 2014-2016 increased with a range of 302 to 309 tons in 2020. Coffee is the main focus of attention due to its global consumption and impact on public health.[6] Results of previous research from 1990 to 2021, Indonesia experienced an increase in coffee consumption of around 32.57%. This increase in coffee intake is often not followed by good knowledge regarding the impact of caffeine consumption, both the risks and benefits.[7] Coffee consumption can provide benefits such as improving mood, increasing concentration, improving physical activity performance, warding off free radicals, and losing weight. The risk of coffee consumption has the potential to experience headaches, dyspepsia, diuresis, anxiety, and poor sleep quality.[8]

METHOD

This analytical observational study utilizing a cross-sectional design was conducted at the Faculty of Medicine, Muhammadiyah University of North Sumatra (UMSU), from January to July 2024

The study population comprised female medical students at UMSU. The sample size was determined using G-Power software (version 3.1) based on a correlation analysis approach with a medium effect size, yielding a required sample of 84 respondents. Participants were recruited using consecutive sampling until the quota was fulfilled.

To mitigate confounding bias regarding hemoglobin levels, strict selection criteria were applied. Inclusion criteria required participants to be female students aged 18–23 years, capable of communicative self-reporting, and willing to sign written informed consent. Crucially, the exclusion criteria eliminated participants who were actively menstruating, currently consuming iron or folic acid supplements, fasting for more than 8 hours prior to testing, or possessing a history of chronic diseases or systemic infections (including HIV, helminthiasis, malaria, tuberculosis, cancer, or known hemoglobinopathies).

Data collection involved direct respondent reporting and biological measurement. Demographic data and individual health histories were recorded initially. Coffee consumption patterns, the independent variable, were assessed using a self-administered Food Frequency Questionnaire (FFQ). Based on the FFQ results, consumption was categorized into two ordinal groups: "Infrequent" (<3 times per week) and "Frequent" (≥3 times per week).

The dependent variable, hemoglobin concentration, was quantitatively measured via capillary blood sampling using a calibrated Point-of-Care Testing (POCT) device (Easy Touch GCHB)

Statistical analysis was executed using

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SPSS software. Univariate analysis was performed to determine the frequency distribution of respondent characteristics. For the bivariate analysis, data normality was first assessed utilizing the Kolmogorov-Smirnov test. Because the hemoglobin data violated the assumption of normality, the non-parametric Mann-Whitney U test was employed to evaluate the difference in median hemoglobin levels between the frequent and infrequent coffee consumption groups. The threshold for statistical significance was established at $p < 0.05$.

RESULTS AND DISCUSSION

Research Results

This study was conducted in accordance with the approval of the Health Research Ethics Commission (KEPK) of the Faculty of Medicine, University of Muhammadiyah North Sumatra with number: 1245/KEPK/FKUMSU/2024

A total of 84 female medical students met the inclusion criteria and participated in this study. The cohort was predominantly 20 years of age (n=29, 34.5%), with the age distribution ranging from 18 to 23 years. Analysis of coffee consumption patterns revealed a heavily skewed distribution, with the vast majority of participants categorized as frequent consumers.

Table 1 Distribution of Samples by Age

Age	Frequency (n)	Percentage (%)
18 years old	7	8.3%
19 years old	13	15.5%
20 years old	29	34.5%
21 years old	23	27.4%
22 years old	10	11.9%
23 years old	2	2.4%
Total	**84**	**100%**

In table 1 there is a frequency distribution based on age, it is found that from the research sample is dominated by 20 years old with a total of 29 (34.5%) samples.

Table 2 Distribution of Coffee Consumption Patterns

Coffee Consumption Patterns	Frequency (n)	Percentage (%)
	12	13.1%
	72	86.9%
Total	**84**	**100%**

In table 2 there is a frequency distribution based on the average coffee intake, at this frequency it is dominated by frequent coffee consumption patterns with a total of 72 (86.9%) samples, then for infrequent coffee consumption patterns with a total of 12 (13.1%) samples.

Table 3 Sample Distribution by Average Hemoglobin Level

	Minimum	Middle Value	Maximum:	
Hemoglobin Level	10 g/dl	12 g/dl	15 g/dl	P= 0.000

In table 3 there is a frequency distribution based on the average

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hemoglobin level, from 84 samples a median value of 11.35 g/dL was obtained, then for the minimum value was obtained 10 g/dL and for the maximum value was obtained 15 g/dL.

Table 4 Comparison of Hemoglobin Levels to Patterns

	Consumption Pattern		
	Seldom	Often	*p-value*
Hemoglobin Level	15 g/dl	11.35 g/dl	p=0.000 (p<0.05)

The statistical analysis demonstrated a highly significant difference in median hemoglobin levels between the groups ($p < 0.01$). Students with frequent coffee consumption exhibited significantly lower median hemoglobin levels (11.35 g/dL) compared to those with infrequent consumption (15.00 g/dL).

DISCUSSION

The findings of this study demonstrate a statistically significant association between high-frequency coffee consumption (≥3 times/week) and lower median hemoglobin levels among female medical students. The frequent consumption group exhibited a median hemoglobin level of 11.35 g/dL, which falls below the World Health Organization's normal threshold of 12.0 g/dL for non-pregnant women, indicating a mild anemic state within this sub-population.

The primary biological mechanism underlying this association is the potent inhibitory effect of coffee on intestinal iron absorption. Coffee contains high concentrations of polyphenols, particularly chlorogenic acid and tannins. When consumed in close temporal proximity to meals, these polyphenolic compounds bind aggressively to non-heme iron (the primary source of iron derived from plant-based foods) in the gastrointestinal lumen. This binding forms large, insoluble iron-tannate and iron-polyphenol complexes that cannot be efficiently absorbed by the enterocytes of the duodenal mucosa

Caffeine can reduce iron absorption by up to 80% if consumed together with iron sources. If you eat iron-containing foods within an hour of drinking caffeine, iron absorption may be reduced. Caffeine causes fluid loss, which in turn reduces the amount of water-soluble B vitamins that the body absorbs. Caffeine not only inhibits the absorption of vitamin B12 but also increases stomach acid, which is an adverse effect of vitamin B complexes.[9] Caffeine has effects on the body that last for different periods of time in different people. To illustrate this, the body of an adult retains caffeine for 3-5 hours, newborns under 6 months for up to 24 hours, pregnant women for 7-8 hours, and smokers for the shortest duration of 2-3 hours.[10]

One possible mechanism that causes tea drinking to affect iron absorption is the production of insoluble iron tannate, which prevents iron from being absorbed efficiently during lumen iron absorption. Morck et al. in 2019 conducted their study Because the greatest reduction in iron absorption occurred when caffeine or

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coffee was consumed with food one hour after a meal, the study found that drinking coffee had the same effect as drinking tea. [11]

Caffeine in moderate doses can regulate the pulse and Caffeine in high doses can increase blood pressure, heart rate, feelings of tension, restlessness, and feeling nauseous. Insomnia, anxiety, headaches, tension, and mood swings are all possible side effects. Caffeine consumption is associated with anxiety, sleep deprivation, and depression in adolescents, according to various studies. Teens who drink sweetened, caffeinated beverages such as cola and energy drinks are more likely to like sugary foods and, if their eating habits are not controlled, experience excess weight gain.[12]

In table 1 there is a frequency distribution based on age, it was found that the research sample was dominated by 20 years old with a total of 29 (34.5%) samples. Based on research conducted by Gera, the caffeine in coffee helps female students stay awake, more focused, and control their anxiety and nervousness, which is a common study habit. Another explanation for this is that previous research has shown a correlation between excessive caffeine consumption and increased levels of anxiety, sadness, and stress among female college students. The consumption of caffeine by female students is inversely proportional to the amount of stress reported by these students. Caffeine consumption increases in female college students when they want to improve their focus and stay alert. College students tend to consume coffee more often because of their need to stay awake and focused in the midst of a busy academic schedule and social activities. Coffee, with its caffeine content, helps boost energy and concentration, especially when they have to stay up late to study or complete tasks.[13]

In table 2 there is a frequency distribution based on the average coffee intake, at this frequency it is dominated by frequent coffee consumption patterns with a total of 72 (86.9%) samples, then for infrequent coffee consumption patterns with a total of 12 (13.1%) samples. Because the concentration of caffeine in coffee can inhibit the body's absorption of iron, drinking more than six cups of coffee daily can affect hemoglobin levels in the blood. If you believe in Samoggia, drinking coffee will make you feel more energized, fit, happy, intelligent, sociable, and a wide variety of other positive vibes. Loftfield cites research showing that more than half of American adults drink coffee every day.[14]

Caffeine, which is found in coffee, is a stimulant that gives people the energy they need to get through their day. However, there are some downsides to drinking coffee, such as an increased risk of iron deficiency. Iron absorption is slowed down or even stopped altogether by caffeine. In addition to lowering hemoglobin levels, caffeine can inhibit the body's ability to transport oxygen from the

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lungs to every cell in the body.[15] The frequency distribution based on average hemoglobin levels is shown in table 4.3. From 84 samples, the median value was 11.35 g/dL, with a minimum of 10 g/dL and a maximum of 15 g/dL. Yocki Yuanti found that among adolescent girls suffering from anemia, the average hemoglobin level was 10.59 g%, with a standard deviation of 0.4702. The results showed that their hemoglobin levels were below the normal range of 12 g/dl set by the World Health Organization. Due to its role in carrying oxygen and carbon dioxide, hemoglobin is an important protein for human health. Health problems caused by hemoglobin deficiency include dizziness, nausea, weakness, and impaired concentration. If conditions such as anemia persist despite treatment, hemoglobin levels will remain abnormal.[16]

In a study that compared hemoglobin levels and coffee consumption patterns among female students at the UMSU Faculty of Medicine, the Mann-Whitney test yielded a p value of 0.000 ($p < 0.05$). The results of this study are in line with Gilang Firmansyah Hidayat's research, which shows that there is a correlation between hemoglobin levels and coffee consumption patterns (p value <0.05, or $p = 0.000$).[14] According to previous research conducted by Tellone et al., caffeine has the ability to lower the number of red blood cells. One hundred milligrams per day is the safe limit for those who drink caffeinated beverages such as coffee and tea. [17]

Blood hemoglobin tends to be unstable and leads to a lack of red blood cells in the body if adults consume caffeinated beverages exceeding 300 mg/day, or the equivalent of three cups of coffee, according to the European Commission and Health Canada's Scientific Committee on Food Safety Authorities. A strong correlation between the frequency of female coffee drinkers and their overall blood health, particularly their hemoglobin levels, was found in a study that compared the two variables. Ensuring proper iron intake affects hemoglobin, a protein found in red blood cells that carries oxygen throughout the body. [18]

Unfortunately, many female college students drink coffee, which contains caffeine, which blocks the absorption of iron from food, especially non-heme iron from plants. According to studies, female college students' hemoglobin levels were lower when they drank coffee frequently, particularly in large quantities or before meals, compared to when they drank less coffee or did not drink it at all.[19]

Caffeine inhibits the body's ability to absorb iron from the intestines, which means the body does not obtain enough iron to produce hemoglobin. As a result, female college students who drink a lot of coffee are at risk of anemia, a disorder characterized by low hemoglobin levels that can cause symptoms such as lethargy, disorientation, and attention deficit. Therefore, it is important for female students to consider the timing and amount

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of coffee consumption, as well as ensure adequate iron intake from food or supplements, to maintain hemoglobin health and prevent negative impacts on overall health. [20]

Several limitations in this study must be acknowledged. First, the cross-sectional design only identifies associations and precludes the establishment of definitive causality between coffee consumption and lowered hemoglobin. Second, there was a substantial quantitative imbalance between the study groups (72 frequent consumers vs. 12 infrequent consumers), which limits the statistical power and generalizability of the comparative analysis. Third, while the FFQ categorized consumption frequency, it did not quantify the precise volume of coffee ingested, the exact caffeine/polyphenol concentrations, the type of coffee (e.g., black coffee vs. milk-based ready-to-drink variants), or the specific timing of consumption relative to meals. Finally, although baseline confounding factors like active menstruation and iron supplementation were controlled via exclusion criteria, comprehensive dietary intake logs (quantifying total daily heme and non-heme iron intake) were not utilized

CONCLUSION

This study demonstrates a statistically significant association between frequent coffee consumption and lower median hemoglobin levels among female medical students. High-frequency coffee intake (≥3 times per week) is associated with hemoglobin concentrations that fall below normal physiological thresholds, likely driven by the polyphenol-mediated inhibition of gastrointestinal iron absorption. These findings underscore the necessity for targeted nutritional education among young women, specifically advocating for the temporal separation of coffee consumption from iron-rich meals to mitigate the risk of iron deficiency anemia. Future longitudinal research utilizing precise volumetric quantification of polyphenol intake and continuous hematological monitoring is warranted to confirm these biological mechanisms within this demographic.

REFERENCES

1. Aryadi MI, Arfi F, Harahap MR. Perbandingan Kadar Kafein dalam Kopi Robusta (Coffea canephora), Kopi Arabika (Coffes arabica) dan Kopi Liberika (Coffea liberica) dengan Metode Spektrofotometri UV-Vis. *Amina*. 2020;2(2):64-70.

2. Dhimas PS, Fahmi NF, Faisal A. Paparan Timbal (Pb) Terhadap Kadar Hemoglobin di dalam Darah. In: *Proceeding 1st SETIABUDI – CIHAMS 2020*. ; 2020:159-165.

3. Astuti Y, Artini D. Pemeriksaan Golongan Darah Dan Kadar Hemoglobin Pada Calon Pendonor Darah Di Puslatpur, Playen, Gunung Kidul. *J Pemberdaya Publ Has Pengabdi Kpd Masy*. 2019;3(3):433-438.

E-ISSN :2722-0877

4. Pangestu SYD, Lestari AS, Priwardani K, et al. Tingkat Pengetahuan Mengenai Anemia Pada Remaja di SMA Negeri 1 Depok. *J Pengabdi Kpd Masy Nusant*. 2022;3(2):430-437.

5. Suryadinata PYA, Suega K, Wayan I, Dharmayuda TG. Faktor Risiko Yang Mempengaruhi Kejadian Anemia Defisiensi Besi: A Systematic Review. *J Med Udayana*. 2022;11(2):6-12.

6. Utama RP. Status Gizi dengan Kejadian Anemia Pada Ibu Hamil. *J Ilm Kesehat Sandi Husada*. 2021;10(2):689-694.

7. Rahayu M. Analisis Pengaruh Konsumsi Kopi Dengan Denyut Jantung Pada Pemuda. *Unistek*. 2019;6(2):5-12.

8. Nidianti E, Nugraha G, Aulia IAN, Syadzila SK, Suciati SS, Utami ND. Pemeriksaan Kadar Hemoglobin dengan Metode POCT (Point of Care Testing) sebagai Deteksi Dini Penyakit Anemia Bagi Masyarakat Desa Sumbersono, Mojokerto. *J Surya Masy*. 2019;2(1):29.

9. Lestary S, Nasution MA, Ridwanto R, Nasution HM. Penetapan Kadar Kafein Ekstrak Daun Teh Hijau Dan Putih Camellia Sinensis (L.) Dengan Kromatografi Cair Kinerja Tinggi. *J Pharm Sci*. 2023;6(3):1407-1415. doi:10.36490/journal-jps.com.v6i3.199

10. Suaniti NM, Saraswati AASD, Putra AAB. Analisis Kafein Dalam Kopi Arabika (Coffea arabica L.) Pada Berbagai Suhu Penyangraian Dengan Metode Spektrofotometer UV-VIS Dan GC-MS. *J Kim*. 2022;16(1):115.

11. Novitasari AE, Alfatika NN. Pengaruh Waktu Ekskresi terhadap Residu Kafein pada Urine Responden Pengkonsumsi Teh Celup Hitam menggunakan Pereaksi Parry. *Indones J Pharm Educ*. 2022;2(3):247-256. doi:10.37311/ijpe.v2i3.22162

12. Fernandi R. Efek Kafein terhadap Kesehatan Manusia. *Cermin Dunia Kedokt*. 2019;46(1):64-69.

13. Mayrizka A. Hubungan kadar hemoglobin terhadap asupan kafein terhadap remaja. Published online 2018.

14. Loftfield E, Freedman ND, Graubard BI, et al. Association of Coffee Consumption With Overall and Cause-Specific Mortality in a Large US Prospective Cohort Study. *Am J Epidemiol*. 2015;182(12):1010-1022. doi:10.1093/aje/kwv146

15. Hidayat GF, Widhiyastuti E. Hubungan Kebiasaan Minum Kopi Dengan Kadar Hemoglobin Pada Pengunjung Kedai "Sederhana Kopi" Surakarta. *J Indones Med Lab Sci*. 2022;3(2):108-118. doi:10.53699/joimedlabs.v3i2.78

16. Yuanti Y. Pengaruh Pemberian Tablet Fe Terhadap Kenaikan Kadar Hemoglobin Pada Remaja. *J Ilm Kesehat Kebidanan*. 2020;9(2):1-11. https://smrh.e-journal.id/Jkk/article/download/109/

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17. Tellone E, Ficarra S, Russo A, et al. Caffeine inhibits erythrocyte membrane derangement by antioxidant activity and by blocking caspase 3 activation. *Biochimie*. 2012;94(2):393-402. doi:10.1016/J.BIOCHI.2011.08.007

18. Ajeng D, Maduratna A, M ETS. Identification Of Hematocrit Values In Teenagers Active Coffee Drinkers. Published online 2022:75-83.

19. Lee D, Jung W, Shin DW. Association of Coffee or Green Tea with Ferritin or Hemoglobin in Premenopausal Women. *Korean J Fam Med*. 2023;44(2):87-94. doi:10.4082/kjfm.22.0133

20. Marini AR, Stefani M. Hubungan Konsumsi Teh Dan Kopi Ready To Drink Serta Kualitas Tidur Terhadap Risiko Anemia Remaja Putri Di SMAN 8 Kota Bogor. *J Nutr Coll*. 2024;13(2):115-126.