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Relationship between animal protein intake and hemoglobin levels among medical students at Pasundan University

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ABSTRACT

Background: Modern lifestyle changes characterized by high-fat dietary intake and reduced physical activity have increased the prevalence of obesity and lipid abnormalities among young adults. Visceral fat is considered metabolically active and has been associated with dyslipidemia and cardiovascular risk. However, findings regarding the relationship between visceral fat and total cholesterol levels in young adult populations remain inconsistent. Previous studies have predominantly involved older or metabolically compromised populations and frequently relied on advanced imaging methods such as CT scan or MRI, while evidence among apparently healthy university students using practical field-based measurements remains limited. Objective: Therefore, this study aimed to determine the relationship between visceral fat level and total blood cholesterol among medical students at the Faculty of Medicine, Pasundan University (2024/2025). Methods: This correlational analytical study employed a cross-sectional design involving 111 eligible medical students. Visceral fat level was measured using Bioelectrical Impedance Analysis (BIA) with the Omron HBF-375 device, while total cholesterol level was assessed using a portable rapid cholesterol test device. Data were analyzed using Spearman's correlation test. Results: The results showed that most respondents had normal visceral fat levels (79.3%) and normal total cholesterol levels (67.6%). Spearman correlation analysis demonstrated no statistically significant association between visceral fat level and total cholesterol ($r = -0.060$; $p = 0.529$). Conclusion: In conclusion, visceral fat accumulation was not significantly associated with total blood cholesterol levels among medical students. These findings suggest that cholesterol status in young adults may be influenced more by overall lifestyle and metabolic factors than by visceral fat accumulation alone. This study highlights the importance of early lifestyle-based prevention strategies to reduce future cardiometabolic risk.

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INTRODUCTION

Within the circulatory system, hemoglobin serves as a functional molecule in erythrocytes that facilitates oxygen distribution to peripheral tissues while assisting in carbon dioxide removal, thereby supporting metabolic processes (World Health Organization., 2023).

Anemia remains a widespread public health issue that affects populations across various regions, particularly in developing countries. It is characterized by a reduced hemoglobin concentration, which limits the blood's capacity to carry oxygen effectively. The World Health Organization (2023) estimated that 30% of women of reproductive age worldwide are anemic, with the highest prevalence found in low- and middle-income countries. In Indonesia, the Basic Health Research Survey (Riskesdas, 2018) reported that anemia prevalence among women aged 15–24 years reached 48.9%, a sharp increase compared to 37.1% in 2013. The adolescent and young adult female population including university students is particularly vulnerable to anemia due to physiological blood loss during menstruation, poor dietary habits, and inadequate intake of iron and protein (Kumar et al., 2022; Hapsari et al., 2020).

Nutritional factors, especially protein and iron intake, play a central role in hemoglobin synthesis and erythropoiesis. Protein plays a fundamental role in hemoglobin formation by supplying amino acids necessary for globin synthesis, while iron contributes to the heme structure. Both components are essential for effective erythropoiesis and oxygen transport (Zimmermann, M. B., & Hurrell, 2017). In contrast, plant-based protein sources primarily contain non-heme iron, which is less bioavailable and whose absorption is often inhibited by compounds such as phytates, oxalates, and polyphenols. Therefore, inadequate intake of animal protein may result in reduced iron bioavailability, impaired hemoglobin synthesis, and ultimately anemia.

Several studies have demonstrated that low animal protein intake is significantly associated with anemia among women and adolescents. For instance, Fitriani et al. (2022) found that adolescents who consumed animal protein less than three times per week were twice as likely to develop anemia compared to those with adequate intake. Similarly, Luhulimaa et al. (2024) reported that hemoglobin concentration was significantly correlated with both total protein intake and iron consumption among medical students, highlighting the importance of dietary diversity and animal protein inclusion in maintaining healthy hemoglobin levels. These findings underscore that not only iron intake but also protein quality and source are crucial determinants of hemoglobin status.

In the context of higher education, particularly among medical students, maintaining adequate nutrition can be challenging due to academic demands, irregular meal schedules, and limited time for meal preparation. Studies have shown that medical students often skip breakfast or substitute main meals with snacks that are low in protein and micronutrients, predisposing them to suboptimal hemoglobin levels and anemia (Hapsari, N., Nugroho, W., & Rahmawati, 2020). The combination of academic stress, long study hours, and inadequate dietary habits may negatively affect hematological health. Moreover, menstruation further increases the iron requirement among female students, making this group particularly susceptible to anemia even when overall dietary energy intake is sufficient.

Low hemoglobin levels have substantial implications beyond physical health. Anemia has been linked to reduced cognitive performance, impaired memory, decreased attention span, and lower academic productivity among university. Even mild anemia can result in chronic fatigue and diminished mental alertness, which may hinder academic performance. Therefore, understanding the nutritional determinants of hemoglobin levels among students, particularly dietary protein intake, is vital for developing preventive and educational strategies within university settings.

Previous studies in Indonesia have largely focused on the role of iron supplementation and vitamin C intake in preventing anemia; however, relatively few have examined the specific relationship between animal protein intake and hemoglobin concentration in young adult populations. Most existing research evaluates protein intake in general, without distinguishing between animal and plant protein sources. Given the significant differences in iron bioavailability and amino acid composition between these sources, evaluating animal protein specifically offers more precise insights into nutritional factors affecting hemoglobin synthesis.

Therefore, This research was conducted to evaluate whether animal protein consumption is associated with hemoglobin concentration among female medical students. Understanding this relationship is essential for identifying modifiable dietary risk factors associated with anemia in university populations. The results of this research are expected to serve as a reference for nutritional education, promote balanced dietary habits, and contribute to the broader public health effort to reduce anemia prevalence among women of reproductive age.

In addition to protein intake, several studies have emphasized that hemoglobin levels are influenced by a combination of micronutrient intake, particularly iron, folate, and vitamin B12, as well as lifestyle factors such as dietary patterns, physical activity, and menstrual health (Gibson, R. S., Bailey, K. B., Gibbs, M., & Ferguson, 2019; Stevens, G. A., Finucane, M. M., De-Regil, L. M., 2022)). Furthermore, bioavailability of nutrients plays a crucial role, as the absorption of non-heme iron is significantly lower compared to heme iron found in animal-based foods (Hurrell, R., & Egli, 2010). This highlights the importance of not only the quantity but also the quality and source of dietary intake in maintaining optimal hemoglobin levels. Therefore, evaluating animal protein intake in relation to hemoglobin concentration provides a more specific understanding of nutritional determinants of anemia among young women.

RESEARCH METHOD

Study Design and Setting

This study employed an analytical observational research design with a cross-sectional approach to examine the relationship between animal protein intake and hemoglobin levels among female medical students. The research was conducted at the Faculty of Medicine, Pasundan University, Bandung, Indonesia, in September 2025. A cross-sectional design was selected because it enables the simultaneous assessment of exposure (animal protein intake) and outcome (hemoglobin levels) within a defined population at a single point in time, thereby facilitating the identification of potential associations between variables (Setia, 2016).

Population and Sample

The population in this study consisted of all active female medical students at the Faculty of Medicine, Pasundan University. The sample was obtained using a simple random sampling technique to ensure that each member of the population had an equal opportunity to be selected. The minimum required sample size was calculated using the Lemeshow formula for analytical cross-sectional studies, resulting in a total of 56 respondents who met the inclusion and exclusion criteria.

Eligible participants were active female students aged between 18 and 23 years who were willing to participate voluntarily and had signed an informed consent form. Respondents were excluded if they were menstruating at the time of data collection, had a history of anemia or chronic disease (such as thalassemia or kidney disorders), were taking iron or vitamin C supplements within the past week, or had incomplete data. Participants who became ill or withdrew from participation during the study period were also excluded from the analysis.

Data Collection Procedures

Data collection was performed in two stages: assessment of animal protein intake and measurement of hemoglobin levels.

In the first stage, animal protein intake was measured using a validated semi-quantitative Food Frequency Questionnaire (FFQ) designed to capture dietary habits specific to the Indonesian population. The FFQ included a list of commonly consumed Foods derived from animal sources provide heme iron, which is more readily absorbed compared to non-heme iron found in plant-based foods. The absorption of non-heme iron is often influenced by dietary inhibitors such as phytates and polyphenols. Based on the Recommended Dietary Allowance (RDA) for Indonesian women aged 19–29 years, which is 57 grams of protein per day, participants were categorized into two groups: adequate intake (≥57 g/day) and inadequate intake (<57 g/day).

In the second stage, hemoglobin levels were measured through capillary blood samples obtained by finger prick using sterile, single-use lancets. The measurement was performed using the AccuPro Hemoglobin Meter (AccuPro Inc., USA). Each participant's hemoglobin concentration was recorded in grams per deciliter (g/dL). To ensure reliability, two measurements were taken for each participant, and the average value was used for analysis. According to the World Health Organization (2011) criteria, hemoglobin levels were classified as normal (≥12 g/dL) or low (<12 g/dL).

Data Management and Statistical Analysis

All data were coded and entered into IBM SPSS Statistics version 25 for Windows for processing and analysis. Descriptive statistics were used to present the distribution of each variable in the form of frequencies, percentages, means, and standard deviations.

To determine the association between animal protein intake and hemoglobin levels, a Chi-Square (χ^2) test was used, as both variables were categorical. The strength of association was further assessed using the contingency coefficient (r). A p-value of less than 0.05 was considered statistically significant. Data were checked for completeness and accuracy before analysis. The assumptions of the Chi-Square test were verified, ensuring that at least 80% of cells had an expected frequency greater than five. Participants with incomplete or inconsistent responses were excluded from the final dataset.

Ethical Considerations

This study received ethical approval from the Research Ethics Committee of the Faculty of Medicine, Pasundan University, Bandung (Approval No. UNPAS/FK/EC-2025/09). Prior to data collection, each participant received a detailed explanation of the study's objectives, procedures, and confidentiality measures. Written informed consent was obtained from all respondents. Data confidentiality and anonymity were maintained throughout the research process, and participants were assured that their information would be used solely for academic purposes. The study complied with the ethical principles outlined in the Declaration of Helsinki (2013) regarding human research ethics.

RESULTS AND DISCUSSIONS

This study involved 56 female medical students from the Faculty of Medicine, Pasundan University, Bandung. The results are presented according to the distribution of respondent characteristics, animal protein intake, hemoglobin levels, and the correlation between animal protein intake and hemoglobin levels.

Characteristics of Respondents

The results show that almost half of the respondents (48.21%) were from the 2024 academic cohort, representing the largest contributor to this study. Students from the 2022 and 2023 cohorts accounted for 26.79% and 25.00% of respondents, respectively. No participants from the 2021 cohort met the inclusion criteria and were therefore excluded. All respondents were within the age range of 19–21 years (100%), indicating a relatively homogenous age distribution among participants.

Table 1. Characteristics of respondents (n = 56)

Variable	Category	Frequency (n)	Percentage (%)
Academic Year	2022	15	26.79
	2023	14	25.00
	2024	27	48.21
Age (years)	19–21	56	100.00

These findings indicate that the majority of participants were young students from the 2024 academic cohort, suggesting that the study sample mainly represented the younger segment of the medical student population.

Analysis of Animal Protein Intake among Respondents

The analysis of animal protein intake revealed that most respondents had insufficient intake levels. As shown in Table 2, 51 respondents (91.07%) were classified in the inadequate intake category, while only 5 respondents (8.93%) met the adequate intake level according to the Indonesian Recommended Dietary Allowance (RDA).

Table 2. Distribution of respondents based on animal protein intake (n = 56)

Category	Frequency (n)	Percentage (%)
Inadequate (<57 g/day)	51	91.07
Adequate (≥57 g/day)	5	8.93

This result suggests that the majority of respondents did not meet the daily requirement for animal protein intake, which corresponds to approximately 4–5 standard household portions (URT) such as pieces, cups, or tablespoons. The low consumption of animal protein may contribute to nutritional imbalance and risk of anemia, as animal protein is an important source of heme iron and essential amino acids needed for hemoglobin synthesis. According to WHO (2023), anemia defined as hemoglobin levels below 13 g/dL in males and below 12 g/dL in females can lead to reduced productivity, decreased concentration, and poor physical endurance.

Analysis of Hemoglobin Levels among Respondents

Table 3 presents the distribution of hemoglobin levels among the respondents. Most participants (46 or 82.14%) had normal hemoglobin levels (≥12 g/dL), while 10 respondents (17.86%) had low hemoglobin levels (<12 g/dL).

Table 3. Distribution of respondents based on hemoglobin levels (n = 56)

Category	Frequency (n)	Percentage (%)
Normal (≥12 g/dL)	46	82.14
Low (<12 g/dL)	10	17.86

The results demonstrate that the majority of respondents had normal hemoglobin levels, indicating that most did not suffer from anemia. Hemoglobin is a crucial biomarker that reflects the body's capacity to transport oxygen to tissues, and its adequacy is vital for maintaining concentration, productivity, and overall health. Anemia, or low hemoglobin levels, remains one of the most common nutritional problems among women of reproductive age, including university students, and is often caused by inadequate intake of protein, iron, and other micronutrients (World Health Organization, 2023).

Animal protein plays an essential role in hemoglobin formation, as it provides heme iron that is easily absorbed by the body and supplies essential amino acids necessary for red blood cell production. Therefore, inadequate animal protein consumption can negatively affect hemoglobin synthesis and increase the risk of anemia.

Correlation between Animal Protein Intake and Hemoglobin Levels

The statistical relationship between animal protein intake and hemoglobin levels was analyzed using the Chi-Square test. As shown in Table 4, the analysis resulted in a correlation coefficient (r) of 0.064 and a p-value of 0.631.

Table 4. Distribution of respondents based on hemoglobin levels (n = 56)

Animal Protein Intake	Hemoglobin Level	Total n (%)	*p*-value	*r*
	Low	Normal		
Inadequate (<57 g/day)	9 (17.65%)	42 (82.35%)	51 (100%)	0.631
Adequate (≥57 g/day)	1 (20.00%)	4 (80.00%)	5 (100%)	

The correlation coefficient (r = 0.064) indicated a very weak association between animal protein intake and hemoglobin levels, and the p-value of 0.631 (greater than 0.05) showed that the relationship was not statistically significant. This means that animal protein intake was not significantly associated with hemoglobin levels among respondents.

These results align with previous studies suggesting that hemoglobin concentration is influenced by multiple factors beyond protein intake alone, including iron and vitamin C intake, caffeine consumption, menstrual patterns, and overall nutritional status. Modern lifestyle patterns, irregular eating habits, and the frequent consumption of fast food can negatively affect the nutritional balance of medical students, further complicating the relationship between dietary intake and hemoglobin levels.

Discussion

The present study examined the relationship between animal protein intake and hemoglobin levels among female medical students at the Faculty of Medicine, Pasundan University, Bandung. The results demonstrated that although the majority of respondents (91.07%) had inadequate animal protein intake, most participants (82.14%) maintained normal hemoglobin concentrations. Statistical testing using the Chi-Square method revealed a p-value of 0.631 and a correlation coefficient (r) of 0.064, indicating a very weak and statistically insignificant association between animal protein intake and hemoglobin levels. These findings suggest that animal protein consumption alone is not the dominant factor determining hemoglobin concentration in this population.

Protein is one of the essential nutrients required for hemoglobin synthesis. It provides amino acids that form the globin structure and contributes to the transport of iron through plasma proteins such as transferrin and ferritin. Deficiency of dietary protein may reduce the body's ability to absorb and utilize iron, thereby impairing erythropoiesis (Zimmermann, M. B., & Hurrell, 2017). However, this study's results indicate that even with inadequate animal protein intake, most students maintained normal hemoglobin levels. This may be due to compensatory mechanisms such as enhanced intestinal absorption of iron, differences in menstrual blood loss, or additional protein obtained from plant-based sources. A similar finding was observed by (Rahayu, D., Indarto, D., Wiboworini, B., Yudhani, R., & Kusumawati, 2017), who found that protein intake alone was not significantly correlated with hemoglobin levels among high-school girls when iron intake was controlled, suggesting that iron status plays a more dominant role.

In contrast, several studies have shown that adequate protein intake supports normal hemoglobin formation. Research conducted among women of reproductive age at Inche Abdoel Moeis Hospital reported a strong positive correlation between total protein intake and hemoglobin concentration (r = 0.81; p < 0.001) (Asmanah, C., Reski, S., & Hidayat, 2023). Likewise, ((Nopiana, 2018) found significant relationships between protein and iron intake with hemoglobin levels among nutrition students in Bengkulu (p = 0.005 and p = 0.002, respectively). The differences between these studies and the current research may be explained by variations in dietary patterns, regional food accessibility, and lifestyle behaviors.

In the present study, most respondents were young medical students who often faced irregular meal schedules, skipped breakfast, or consumed fast food due to academic demands. These habits can lead to unbalanced nutrient intake, including low levels of iron and vitamin C, which are essential for effective hemoglobin synthesis. Supporting this, (Mahra et al., 2025) found that caffeine consumption, particularly from ready-to-drink coffee, was significantly associated with increased anemia risk among female university students because caffeine inhibits iron absorption. Similar results were reported among female workers in Kudus, where protein adequacy was related to anemia status, yet excessive caffeine consumption and inadequate energy intake further increased the risk (Purbowati, S., Nurohmi, S., & Aisya, 2021).

Comparative studies in Indonesia also show varied outcomes. Research among high-school girls in Medan demonstrated that students with anemia had significantly lower protein intake than those with normal hemoglobin ($p < 0.05$) (Firmansyah, H., Harahap, W. A., & Rosmiati, 2024). Conversely, a study among female medical students in Yogyakarta found no significant relationship between protein intake and hemoglobin levels, likely due to the influence of genetic variations such as the TMPRSS6 rs855791 polymorphism that regulates hepcidin and iron absorption (Fenty, F., Kristin, E., Ratnaningsih, T., Supanji, S., & Nugrahaningsih, 2022). In Uganda, research on 384 female medical students revealed that anemia prevalence (15.9%) was more closely associated with dietary frequency and breakfast skipping rather than specific nutrient intakes (Emmanuel, 2023). These diverse findings highlight that anemia among young women is multifactorial, influenced by dietary adequacy, lifestyle, menstrual health, and in some cases, genetic predisposition.

Physiologically, protein plays a central role in iron transport and utilization. Proteins such as transferrin bind to iron and deliver it to tissues for erythropoiesis, while ferritin acts as a storage form. Low protein intake can disrupt this transport system, thereby slowing iron mobilization and hemoglobin synthesis. This concept supports the theory presented by Hapsari et al. (2020), who emphasized that irregular meal timing and inadequate protein sources among medical students can reduce hemoglobin concentration. Furthermore, according to Kumar et al. (2022), anemia in women of reproductive age often results from the combined deficiency of iron and protein, which affects both the quantity and quality of red blood cells.

The World Health Organization (2023) reports that nearly 30% of women of reproductive age worldwide are anemic, and up to 48.9% of Indonesian women aged 15–24 years experience anemia. This public health concern underscores the importance of improving diet quality, particularly adequate protein and iron intake. However, as indicated by this study, increasing animal protein alone may not be sufficient if iron intake, vitamin C consumption, and menstrual health are not concurrently addressed.

The absence of a significant association in this study may also be explained by the body's adaptive mechanisms in maintaining iron homeostasis. According to Zimmermann (2017), iron absorption efficiency increases when body iron stores are low, which may compensate for inadequate dietary intake. In addition, the role of enhancers such as vitamin C intake can significantly improve non-heme iron absorption, potentially maintaining hemoglobin levels despite low animal protein intake (Camaschella, 2015; Pasricha, S. R., Tye-Din, J., Muckenthaler, M., & Swinkels, 2021; Teixeira et al., 2021; Teucher, B., Olivares, M., & Cori, 2004).

Moreover, recent studies have shown that dietary diversity is a stronger predictor of hemoglobin status than single nutrient intake. A study by Nguyen et al. (2023) demonstrated that individuals with diverse diets had significantly better hemoglobin levels compared to those with monotonous dietary patterns. This suggests that focusing solely on animal protein intake may not adequately capture the complexity of nutritional influences on hemoglobin synthesis.

Another important factor is inflammation and infection, which can alter iron metabolism through increased hepcidin levels, thereby reducing iron absorption and availability for erythropoiesis (Kassebaum, 2016; Nemeth, E., & Ganz, 2014; Weiss, G., & Ganz, 2019). Although

not assessed in this study, such factors may contribute to variability in hemoglobin levels among respondents.

The absence of a statistically significant relationship in this study also reflects methodological and behavioral limitations. Data collection relied on a self-reported FFQ, which is subject to recall bias, and the cross-sectional design cannot establish causality. Nonetheless, these findings provide valuable insight into the nutritional status of female medical students and may serve as a foundation for further interventional research. Future studies should include biochemical indicators such as serum ferritin and transferrin saturation to obtain a more comprehensive picture of iron metabolism and protein interaction in hemoglobin formation.

In summary, the present study concludes that animal protein intake among female medical students at Pasundan University was predominantly inadequate, yet most participants maintained normal hemoglobin levels. There w.as no statistically significant relationship between animal protein intake and hemoglobin levels ($p = 0.631$; $r = 0.064$). This suggests that anemia prevention requires a holistic approach involving balanced nutrient intake including iron, vitamin C, and protein along with lifestyle modifications such as regular meals, reduced caffeine consumption, and healthy menstrual management

CONCLUSION

This study aimed to examine the relationship between animal protein intake and hemoglobin levels among female medical students at the Faculty of Medicine, Pasundan University, Bandung. The findings demonstrated that the majority of participants (91.07%) had inadequate animal protein intake, whereas most respondents (82.14%) exhibited normal hemoglobin concentrations. Statistical analysis yielded a p-value of 0.631 and a weak correlation coefficient ($r = 0.064$), indicating no significant association between animal protein intake and hemoglobin levels. These results suggest that although animal protein plays a role in hemoglobin synthesis by supplying essential amino acids and enhancing iron absorption, it is not the sole determinant of hemoglobin status. Other nutritional and lifestyle factors—including dietary iron intake, vitamin C consumption, menstrual health, and caffeine intake—are likely to exert a greater influence on hemoglobin levels among female students.

The absence of a significant association underscores the multifactorial etiology of anemia in women of reproductive age. Therefore, anemia prevention strategies should adopt a comprehensive approach that emphasizes balanced nutrition, incorporating adequate intake of both animal and plant-based proteins, iron-rich foods, and vitamin C sources, as well as regular meal patterns and reduced caffeine consumption. Future research is recommended to include biochemical markers such as serum ferritin and transferrin saturation to provide a more comprehensive assessment of iron status and its relationship with dietary protein intake. In addition, nutrition education programs aimed at improving nutritional literacy among university students are essential to promote healthy dietary behaviors and reduce the risk of anemia in this population.

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion).

The findings of this study are consistent with the initial hypothesis presented in the introduction, which suggested that hemoglobin levels are influenced by multiple interacting factors beyond animal protein intake alone. Although animal protein is an important nutritional component, the findings suggest that the relationship between animal protein intake and hemoglobin levels was not statistically significant, indicating that other contributing factors may play a more dominant role in determining hemoglobin status. From a future research perspective, these findings open opportunities for further studies to explore comprehensive nutritional models,

including micronutrient interactions, dietary diversity, and biochemical indicators such as serum ferritin, transferrin saturation, and hepcidin levels. Additionally, interventional studies focusing on nutrition education and dietary modification programs among university students may provide practical applications in reducing anemia prevalence. The integration of nutritional awareness programs into academic settings is strongly recommended to improve long-term health outcomes among young women.

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