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The Relationship Between Protein and Iron Intake and Hemoglobin Levels of Students, Class of 2019, Faculty of Medicine, Christian University of Indonesia

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ABSTRACT

Adequate nutrition is essential for red blood cell formation and maintaining normal hemoglobin levels. Deficiencies in essential nutrients can disrupt hemoglobin synthesis and oxygen transport throughout the body. Protein and iron are among the most important nutrients involved in these processes. Protein contributes to cell formation and tissue development, while iron is a vital component of hemoglobin. Low hemoglobin levels can lead to anemia, which can reduce physical performance and productivity. This study aimed to analyze the relationship between protein and iron intake and hemoglobin levels among college students. An observational, analytical cross-sectional study was conducted. Sixty participants were selected using purposive sampling. Dietary intake data were collected through questionnaires and analyzed using NutriSurvey software. Hemoglobin concentration was measured using photometry. The relationship between nutrient intake and hemoglobin levels was examined using the Spearman correlation test. The results showed that 66.7% of participants had insufficient protein intake, while 33.3% met the recommended intake. For iron intake, 21.7% of participants had insufficient intake, and 78.3% had sufficient intake. Statistical analysis showed no significant relationship between protein intake and hemoglobin levels, with an r value of 0.082 (p=0.535). Conversely, iron intake was significantly associated with hemoglobin levels with an r value of 0.631 (p=0.000). In conclusion, protein intake was not associated with hemoglobin concentration, while iron intake showed a significant relationship with hemoglobin levels. Therefore, adequate iron consumption can play an important role in maintaining normal hemoglobin status.

INTRODUCTION

Hemoglobin (Hb) is a protein consisting of four main parts in red blood cells that bind to heme, made of porphyrins that have iron (Fe) content (Gunadi, 2016). Hemoglobin is a polypeptide (protein) in the bloodstream that transports iron. Heme has a prosthetic group with an iron atom, while globin is a polypeptide (protein) chain. Hemoglobin functions to bind and

circulate oxygen (O_2) throughout the body and carry the final product of the respiratory process, namely carbon dioxide (CO_2) (Saraswati, 2021).

A person may fail to focus on learning and may be weak and unfit during daily activities. It can be caused by oxygen deficiency in the nerve tissue of the brain and muscle tissue. Blood cells containing hemoglobin are the bonds between iron (heme) and protein (globin). A person's hemoglobin level can be influenced by various things such as gender, age, eating habits, and overall health conditions (Kemkes, 2011).

Hemoglobin in red blood cells is needed to ensure the status of anemia. Under prevalent conditions, male hemoglobin levels typically range from 13 to 18 grams per deciliter, and female hemoglobin levels typically range from 12 to 16 grams per deciliter. A lower-than-normal amount of hemoglobin falls into the category of anemia, which is categorized by age group and sex (Pratama, 2017).

According to the World Health Organization (WHO), the incidence of anemia worldwide is still high; it is estimated that as many as 1.3 billion people in the world suffer from anemia, with a prevalence of 32.9%. The 2023 Indonesian Health Survey (*Survei Kesehatan Indonesia*, SKI) shows that the prevalence of anemia in toddlers to adolescents reaches alarming figures, namely 23.8% at the age of 0-4 years, 15.3% at the age of 5-14 years, and 15.5% at the age of 15-24 years. Anemia is still a health problem in Indonesia, spread across all districts and cities. Anemia is one of the problems that needs to be solved because the incidence of anemia can reduce work productivity and the level of family life welfare (SKI, 2023).

Protein is essential for the body as a building and regulating material. Protein deficiency can result in obstacles in the absorption and distribution of nutrients. Decreased protein consumption will inhibit the availability of protein in the blood circulation. Iron (Fe) is carried by transferrin in the bloodstream to form hemoglobin. When transferrin levels decrease in the blood, this inhibits iron transport and causes reduced hemoglobin levels (Putri et al., 2023). The formation of new red blood cells is strongly influenced by protein and iron intake. Insufficient protein and iron intake can interfere with all erythropoiesis processes. If protein and iron intake are insufficient, the body will dismantle protein and iron reserves to cover the deficiency (Pratama et al., 2020).

Regarding the stage of human growth and development, students are included in the category of late adolescence and early adulthood, aged 18 – 25 years. If the body is unable to adjust due to insufficient food intake or various other factors, it will cause

anemia. Knowledge level is significantly related to the incidence of anemia. Nutrition students have better knowledge of science-related fields; research found that 41% of nutrition students have a relatively low level of knowledge of anemia. This is accompanied by an incidence rate of anemia of 45% of the entire study population (Choiriyah et al., 2024). Based on the above problems, this research was conducted to determine the correlation between the intake of the two nutrients and the level of hemoglobin in the study subjects.

RESEARCH METHODS

Study Design

This study employed a non-experimental quantitative design with a cross-sectional approach. The study examined the correlation between protein and iron consumption and hemoglobin levels in students of the Faculty of Medicine, Christian University of Indonesia, class of 2019.

Data Collection and Analysis

Data were collected by taking blood samples and questionnaires from 60 FK UKI students, class of 2019. To check the status of anemia, a Hematology Analyzer was used in the laboratory of UKI Hospital. The 2x24-hour Food Recall form is used to determine the type and amount of energy, namely protein, eaten in 24 hours. After the data from the food recall form is obtained, the data is entered into NutriSurvey to obtain a more accurate nutritional adequacy value. The questionnaire is used to find out the student's identity, illness history, age, and gender.

RESULTS AND DISCUSSION

The data collection process used the purposive sampling technique, which considers the inclusion criteria set by the researcher. Through this method, 60 students of the Faculty of Medicine UKI class of 2019 were selected as research subjects. The characteristics of the respondents are presented in Tables 1–5.

Table 1. Characteristics of respondents by gender category

Gender	Quantity	Percentage (%)
Male	14	23.3
Women	46	76.7
Total	60	100

Table 2. Characteristics of respondents by age category

Age	Quantity	Percentage (%)
17 years	8	13.3
18 years old	34	66.7
19 years old	18	30
Total	60	100

Table 3. Characteristics of respondents according to hemoglobin levels.

Hemoglobin Levels	Quantity	Percentage (%)
Normal	45	75
Low	15	25
Total	60	100

Table 4. Characteristics of respondents according to protein intake.

Protein Intake	Quantity	Percentage (%)
Less	40	66.7
Enough	20	33.3
Total	60	100

Table 5. Characteristics of respondents according to iron (Fe) intake.

Iron Intake	Quantity	Percentage (%)
Less	13	21.7
Enough	47	78.3
Total	60	100

The characteristics of the study respondents were based on gender; out of a total of 60 respondents, 14 were male, and 46 were female. Adolescents have a typical lifestyle, namely inappropriate eating habits and a misunderstanding of nutrition in nutritional problems that cause anemia (Adriani & Wirjatmadi, 2014; Dumilah, 2017).

Iron intake was obtained through the food recall method for two days. Iron consumption calculations were carried out using Nutrisurvey software and then analyzed to see the level of iron adequacy. According to the results of the study of 60 participants, the level of iron adequacy is still lacking (<80% of the AKG); there are 13 people, or about 21.7%, who have a condition of iron deficiency, while 47 people, or 78.3%, have sufficient iron levels (≥80% AKG). Iron has a very crucial role in forming red blood cells. Adolescents with low iron consumption are 7.1 times more likely to feel anemia than adolescents with adequate iron intake (Alfani & Nuriannisa, 2022).

Anemia is a condition where hemoglobin levels are below normal limits. The results of the analysis of the respondents' hemoglobin (Hb) levels showed that individuals with Hb < 12 g/dl were included in the anemia group, while those with Hb ≥ 12 g/dl were included in the non-anemia group. Hb measurement results were obtained from 60 respondents; 15 (25%) were in the anemia group, while 45 (75%) did not have anemia. Anemia can arise due to a combination of various factors, including a lack of essential nutrients, parasitic infections and certain diseases, blood loss during menstruation, and hereditary factors that affect a person's health condition (Depkes Jakarta I, 2010).

This study assessed protein consumption by conducting a 24-hour recall and then comparing the results with the needs set based on the 2013 AKG. Based on the level of adequacy, protein consumption is divided into two groups. Protein intake is considered adequate if it reaches at least 80% of the recommended AKG, while values that are less than that limit are categorized as insufficient intake. The results of protein intake measurements carried out on 60 respondents showed insufficient protein intake. (<80% of the AKG) were 40 people (66.7%) of the respondents, while of the 60 people surveyed with sufficient protein levels (≥80% of the AKG), as many as 20 people (33.3%) of the respondents.

Table 6. Correlation of protein intake level and hemoglobin (Hb) levels.

Protein Intake	Hemoglobin Levels						p-value
	Normal		Low		Total		
	n	%	n	%	n	%	
Less	31	77.5	9	22.5	40	100	0.535
Enough	14	70.0	6	30.0	20	100	

Table 7. Correlation of iron intake (Fe) levels and hemoglobin (Hb) levels.

Iron Intake	Hemoglobin Levels						p-value
	Normal		Low		Total		
	n	%	n	%	n	%	
Less (<80% AKG)	3	23.1	10	76.9	13	100	0.000
Enough	42	89.3	5	10.7	47	100	

Based on Table 6, most of the respondents, both in the group with low and sufficient protein intake, had Hemoglobin (Hb) levels in the normal category. Furthermore, in the group with low protein intake (<80% AKG), the proportion of respondents with normal hemoglobin levels reached 77.5%, while in the group with sufficient protein intake (≥80% AKG) it was 70.0%. The results of the Spearman Rank test showed p = 0.535, indicating no significant correlation between protein intake and hemoglobin levels. These findings show that hemoglobin levels can be influenced by various other factors besides protein intake, such as iron adequacy, vitamin B12, folic acid, health conditions, and the body's ability to absorb and utilize the nutrients consumed.

Table 7 shows that the adequacy of iron intake is related to the hemoglobin status of the respondents. In the group with iron deficiency (<80% AKG), the proportion of respondents with low hemoglobin levels reached 76.9%. On the other hand, in the group with adequate iron nutritional intake (≥80% AKG), 89.3% of respondents had normal hemoglobin levels. Based on Spearman's results, p = 0.000, indicating a very significant correlation between iron intake and hemoglobin levels. These findings indicate that iron adequacy plays an important role in maintaining normal hemoglobin levels.

Correlation between protein intake and hemoglobin (Hb) levels

The results of statistical testing using Spearman Rank indicate that the level of protein consumption does not correlate significantly with hemoglobin levels. However, this research found that respondents had protein intake that did not meet nutritional needs, with a percentage of 66.7%. Based on the results of the 2x24-hour food recall, many respondents consumed few foods containing iron sourced from animals such as eggs, fish,

meat, and dairy products as sources of heme iron. Not a few respondents chose plant-based protein sources, including seeds, nuts, and vegetables, as the main source of iron, which contributes to meeting daily iron needs through non-heme iron. The lower the protein level, the more likely a person is to suffer from anemia. In addition, protein helps carry nutrients, including iron (Setyandari, 2017).

Foods high in protein from animals contain more iron than plant-based protein sources, as animal proteins provide a more complete essential protein building profile that suits the body's needs. Eating protein from animals can increase iron absorption in the body. Insufficient protein consumption can disrupt the body's iron absorption process. This condition can reduce the availability of iron for hemoglobin formation, so it has the potential to cause iron deficiency and anemia (Syatriani & Aryani, 2010).

Low protein consumption can interfere with the absorption and distribution process of nutrients. Low protein intake from food can also interfere with protein synthesis in the blood. Transferrin and ferritin are known as iron-binding proteins. plays a role in transporting iron in the blood (Setyandari, 2017). Transferrin carries iron in the form of ferroxide, which delivers iron to the spinal cord so that hemoglobin can be formed. If transferrin levels decrease to suboptimal levels, hemoglobin levels may also decrease (Lewa, 2016; Rizal et al., 2023).

Another major factor that influences the incidence of anemia is protein consumption and the presence of inhibitors and enhancers in the diet. Protein plays a vital role in red blood cell formation and immune function. Adequate protein intake can help improve red blood cell health, which carries oxygen throughout the body. Some studies have shown that protein deficiency can worsen anemia, especially in 49 adolescents who are in the middle of their growth period (Syarfaini et al., 2025).

Protein intake, among other nutrients, has been identified as an important factor that significantly affects the prevalence of anemia in adolescent girls. The results of this research are in line with the fact that the majority of respondents have low protein consumption, with a proportion of 90.9%. However, the results of this research do not support the results of the previous research. As stated by Matayane (2014), the study explained that iron consumption has a relationship with the hemoglobin levels of female students. Protein has a crucial role in the formation of body tissues, structuralization, development, transporting oxygen and nutrients, and supporting the functioning of

the immune system (Syatriani & Aryani, 2010).

Previous studies have shown a significant correlation between protein consumption and hemoglobin levels in pregnant women, with a p-value of 0.042. The results of the research indicate that pregnant women with anemia tend to have lower protein intake than those without anemia. Protein plays an important role in the movement of iron in the human body, so protein deficiency inhibits the distribution of iron and increases the risk of iron deficiency and anemia (Zalfa et al., 2024).

The results of this research in Table 6 are in accordance with a study conducted by Dewi and colleagues in 2018, which found no association between protein consumption and hemoglobin levels in adolescent girls who experienced anemia (p = 0.515). This is also in line with a study conducted by Matayane and colleagues in 2014, which also showed no association between protein consumption and hemoglobin levels (p = 0.138).

Correlation of iron intake (Fe) and hemoglobin (Hb) levels

Statistical analysis found a strong association between iron consumption and hemoglobin levels, with a p-value = 0.000, indicating a significant association between iron consumption (Fe) and hemoglobin (Hb) levels. Increased iron consumption is associated with increased hemoglobin levels, so the incidence of anemia becomes low. One micronutrient that plays a role in the hematopoiesis process is iron, because this mineral is needed for hemoglobin synthesis, the main component of red blood cells (Kristin et al., 2022).

In adolescence, increased growth and development increase the need for nutrients, including minerals, compared with the previous period. Minerals that need special attention are calcium, iron, zinc, and magnesium because they play an important role in various physiological processes of the body. The recommended daily needs include calcium of 1000 to 1500 mg, iron of 26 mg, sodium of 1200 to 1500 mg, and water consumption of 6–8 glasses daily (Herawati et al., 2025).

The intake of iron (Fe) needed by the body can be obtained from a variety of foods, such as red meat, kale, spinach, nuts, and other sources. This microelement plays an important role in hemoglobin production. Iron is a microelement that is very important for the body. This substance is needed to form blood, which means the synthesis of hemoglobin. Furthermore, this mineral also functions in the production of myoglobin, a protein that carries oxygen to muscles; collagen, a protein found in bones, cartilage, and connective tissue; and enzymes. Iron also plays a role in the

immune system (Kristin et al., 2022; Devi et al., 2023).

Food provides iron in two main forms: heme iron, which is generally from animal food sources, and non-heme iron, which is found more in plant foods. Between the two, heme iron is easier for the body to utilize because it has a relatively high absorption rate, which is about 25% of the amount consumed. Meanwhile, non-heme iron has a lower absorption rate than heme iron. In addition, heme iron is transported by a specific transporter that delivers it to the cell membrane and into the blood (Pasa et al., 2024).

Absorption of iron in the intestines. Adults absorb iron primarily in the duodenum and upper jejunum through differentiated enterocytes in the middle and upper villi. Iron in food is mainly found in two forms, namely heme iron (HI) and nonheme iron (NHI). HI, which is primarily derived from animal food, is the most efficiently absorbed form. NHI is mainly found in ferrous iron (Fe3+) and is abundant in plant foods and iron-fortified foods (e.g., refined grains). HI and NHI are transported across the brush-border (BBM) membrane of enterocytes (Qiu et al., 2025).

The absorption of non-heme iron takes place through several stages, starting in the intestinal lumen and entering the blood circulation. In food, non-heme iron is generally found in ferrous form (Fe^{3+}), while the form that can be absorbed by intestinal epithelial cells is ferrous (Fe^{2+}). Therefore, reducing Fe^{3+} to Fe^{2+} is an important step before iron is transported to enterocytes using a specialized transporter known as DMT1 (Divalent Metal Transporter *1*) (Qiu et al., 2025).

Once absorbed by enterocytes, sufficient amounts of iron are transported to the basolateral side of the cell to enter the blood circulation. The release of iron from enterocytes is mediated by ferroportin (FPN/SLC40A1), which acts as a key protein in iron export. During the process, hephaestin (HEPH) helps convert iron in the form of ferrous (Fe^{2+}) to ferric (Fe^{3+}). The ferrous iron that has been released then binds to apotransferrin in the portal circulation, so that it can be transported and utilized by various body tissues (Qiu et al., 2025).

CONCLUSION

The results of this research concluded that protein intake did not have a significant effect on hemoglobin levels (p=0.535). On the other hand, iron intake has a real relationship with hemoglobin levels (p=0.000), so iron adequacy has an important role in maintaining normal hemoglobin levels. Due to the limitations of research using small-scale samples, the results of the study are not fully described.

Further research is expected to use larger sample sizes.

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