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The Correlation between Iron and Protein Intake in the Hemoglobin Levels of the Faculty of Medicine Students, Unram

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Abstract: Anaemia is a global burden disease that mostly occurs in the reproductive age. About 31.2% of women of reproductive age (15-49 years) have anaemia. This condition may affect oxygen transport in the body and interfere with some bodily functions. Several factors may induce anaemia; iron deficiency is one of them. An amount of iron and protein intake may contribute to haemoglobin levels. This study aims to determine the correlation between iron and protein intake and haemoglobin levels among students in the Faculty of Medicine at the University of Mataram. This is an observational analytic study using cross-sectional methods that includes students aged 17-20 years old. Data is taken in May–June 2024 using a spectrophotometer for checking haemoglobin levels. Iron and protein intake were traced by a 24-hour food records questionnaire over 2 days. Results: There are 118 samples with 25.42% male and 74.58% female. Normal mean haemoglobin levels were detected in this study (12.59±0.82). The correlation tests, with the t-test for iron and protein intake, are not significant, with p-values of 0.246 and 0.254, respectively. Also, total protein and iron intake from this study, with an Anova F-test, is not significant, with a p-value of 0.408. The amount of consumption of iron and protein intake is not significant in the hemoglobin levels of Faculty of Medicine Students of the University.

Keywords: Anemia, medical student, mataram, iron, protein.

Introduction

Anaemia is a condition in which haemoglobin (Hb) levels are below normal, so the capacity of oxygen transport is inadequate physiologically. It can be described as a reduction in the proportion of red blood cells (erythrocytes) (Billet, 1990; Duryea and Schell, 2023). As we know, red blood cells contain a protein called haemoglobin that delivers oxygen to the tissues throughout the body. Within the normal range, haemoglobin varies by age and gender. The level of haemoglobin in children is 11.0 to 16.0 g/dL, whereas in adults, it is 13.5 to 18.0 g/dL for men and 12.0 to 15.0 g/dL for women. In special conditions like pregnancy, it is based on trimester, but overall must be greater than 10.0 g/dL (Wang, 2019; O'Neil, 2017). The World Health Organisation (WHO) categorizes anemia when Hb levels are lower than 12.0 g/dL for females and 13.0 g/dL for males (Safiri et al., 2019). Several factors lead to anaemia, such as low nutrition, loss of iron heavily from blood and sweat, food containing high phytate, low stomach acid, absorption disturbance in the gut, loss of blood because of surgery and menstruation, or many factors that are related to blood loss (Thompson et al., 2011).

Anaemia is not a diagnosis but a clinical manifestation of an underlying disease. About 40% of children and 30% of reproductive-age women experience anaemia (Duryea and Schell, 2023; Safiri et al., 2019). WHO reported in 2019 that global anaemia prevalence was 29.9%, which is equivalent to over half a billion women aged 15-49 years old (WHO, 2019). In Indonesia, anaemia is still a global burden disease that mostly affects adolescents, especially girls. About 31.2% of women of reproductive age (15-49 years) had anaemia in 2019, according to the WHO (WHO, 2019; Sari et al., 2022). The impact of anaemia has significantly disturbed adolescent health because of inadequate oxygen transport; further, it interferes with cognitive function, inhibiting the growth and development of psychomotor. Most of the population has anemia because of iron deficiency (Samson et al., 2022).

Some studies have variation in the results; a study of 190 women in Bantul reported that the iron intake in anaemic respondents was low and significantly associated with anaemia (Hardianti et al., 2020). Another study showed that donors with high heme-iron intake may maintain iron stores, enabling recovery of Hb levels after blood donation (Timmer et al., 2020). However, a study of medical students in Samratulangi University demonstrated that there was no significant relationship between iron intake and protein intake with the haemoglobin levels (Matayane et al., 2014). About 30% of the population has an iron deficiency that leads to anaemia. Iron oral supplementation significantly increases haemoglobin levels with 100 mg every 8 hours as the dosage. This efficacy is equivalent with or without vitamin C consumption (Li et al., 2020). Inadequate iron intake may raise the risk of anaemia 3.09-fold in adolescents, and there is a positive correlation between iron intake and haemoglobin levels ($p = 0.03$). On the other hand, protein may support the iron metabolism and haemoglobin synthesis (Jumiyati et al., 2023; Yanti et al., 2024).

Protein consumption with adequate intake is associated with higher haemoglobin levels ($p = 0.00$). In adolescents, insufficient protein intake is associated with a 30-fold higher risk of anaemia (Jumiyati et al., 2023; Erningtyas et al., 2022). The protein enhances the transport and absorption of iron. An intervention of combining iron-rich foods with protein may raise haemoglobin by 2.17 g/dL. Protein-deficient diets may exacerbate the anaemia, while protein supplementation improves the outcome of anaemia, as confirmed by a systematic review (Erningtyas et al., 2022; Harahap et al., 2023). This research topic, with medical students as participants, has not been conducted in the province of West Nusa Tenggara; therefore, we conclude that it is important to conduct this topic in our area.

Methods

Study design

This is an observational analytic study with a cross-sectional approach that was conducted from May to June 2024. Respondents have different protein and iron intake based on their habits.

Population and sample

This study included students in the Faculty of Medicine at the University of Mataram with inclusion and exclusion criteria. Students in 17-20 who registered as active students in the Faculty of Medicine at The University of Mataram and were willing to contribute to this research are the study. Students with infectious diseases such as HIV and tuberculosis, a history of blood disorders, chronic diarrhoea for several days before, and students who have received or donated any type of blood in the last 3 months are excluded. We used non-probability sampling with the total sampling method. The analytic nonparametric calculation has been performed, and the minimum sample size is 66 individuals, with P1 at 36.1% and P2 at 63.9%, based on previous research.[17] To anticipate dropout, we add 10% of the sample, and it will be a minimum of 73 samples.

Data collection

Data were collected primarily using a 24-hour food records questionnaire over 2 consecutive days. Then haemoglobin was tested using a spectrophotometer. Peripheral blood was taken and mixed with Drabkin's solution to cleave haemoglobin to become cyanmethemoglobin, and absorption capacity was tested on a 540 nm wavelength in a photoelectric calorimeter or spectrophotometer.

Data analysis

All the data that we have collected, we presented in percentages in a table. Demographic data were analysed univariately. Food records data and hemoglobin were analyzed in a bivariate analysis with an unpaired T test.

Ethical statement

Ethical clearance has been obtained in the Ethics Commission health research of the University of Mataram with ethic number 061/UN18.F8/ETIK/2024.

Results and Discussion

There were 118 students in the Faculty of Medicine at The University of Mataram have completed this study, with a proportion of males and females of 25.42% and 74.58%, respectively. The mean of iron intake was 13.97 ± 15.75 mg, and protein intake was 81.86 ± 46.82 mg per day. All the sample characteristics were recorded in Table 1.

Table 1. Sample characteristics

Characteristics	n=118
	n/mean (%/SD)
Gender	
Male	30 (25,42)
Female	88 (74,58)
Age (years)	19,22 ± 0,79
Height (cm)	158,94 ± 8,49
Weight (kg)	57,61 ± 15,93
Body Mass Index (kg/m^2)	22,57 ± 4,81
Hemoglobin levels (mg/dl)	12,59 ± 0,83
Mean iron intake (mg)	13,97 ± 15.75
Mean protein intake (g/hr)	81,86 ± 46,82

Table 2. Bivariate analysis tests each variable

Variables	Hemoglobin levels
	p-value
Iron intake	0,246
Protein intake	0,254
Iron and protein intake	0,408

The measurement of haemoglobin using a spectrophotometer found that 37.29% were anaemic (below 12 g/dL), with 42 persons (35.59%) having light anaemia, and 2 of them (1.70%) were moderate anaemic (graphic 1). Statistical correlation tests for iron intake and protein were not significant, with p-values of 0.246 and 0.254, respectively (p-values above 0.05). When iron intake and protein intake were combined, the statistical correlation test was also not significant (p-value > 0.05) with p p-value of 0.408. The correlation tests are recorded in Table 2.

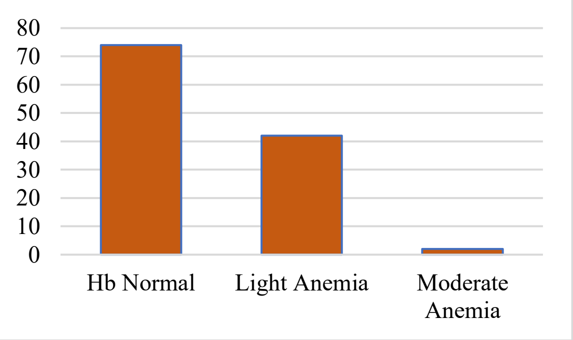

Figure 1. Anemia prevalence in faculty of Medicine The University of Mataram

Discussion

Our study aims to determine the relationship between iron and protein intake on haemoglobin levels in students of the Faculty of Medicine at the University of Mataram. The results of statistical tests of the relationship between iron and protein intake partially (individually) obtained a p-value of 0.246 and 0.254; the p-value is greater than 0.05. For the relationship between iron and protein intake together, the p-value was 0.408, which was greater than 0.05. This shows there is no correlation between iron and protein intake on haemoglobin levels in students of the Faculty of Medicine,The University of Mataram.

In some of the same studies, there are varying research results on the analysis of the relationship between iron and protein intake to haemoglobin levels. Some studies reported a relationship Pradanti et al., Hardianti et al., and Sitorus et al. Also, some other studies reported no relationship between iron and protein intake and haemoglobin levels (Matayane et al., 2014; Kristin et al., 2022; Indraswari et al., 2024). The absence of a relationship between iron intake and haemoglobin levels can be caused by several factors, including sufficient iron reserves and good iron absorption to meet the body's need for iron Indraswari et al., 2024. In people whose iron intake is less but whose haemoglobin levels are normal or not anaemic, it can be caused by iron reserves in the body still meeting their needs. Women have iron stores of about 300 mg, which can last for 6 months. Thus, even though iron intake is lower, the body can meet the iron requirement from iron stores (Kristin et al., 2022).

The relationship between iron and haemoglobin has been described in previous literature. Iron is a major component in the process of hematopoiesis or haemoglobin synthesis, especially in the final stages of heme formation. Heme iron has higher bioavailability than non-heme iron. Absorption is around 7 to 22% compared to non-heme iron, which ranges from 1 to 6%. In addition, other components, such as biotin, vitamin B6, and vitamin B12, are required for globin synthesis (Sitorus et al., 2024). In the final stage, the incorporation of ferrous iron into protoporphyrin III occurs. The process is catalysed by the enzyme ferrocatalase. Furthermore, the interaction between heme and globin will produce haemoglobin. In addition to iron consumption, it is important to pay attention to the consumption of other micronutrients that can increase the absorption and metabolism of iron (Putri and Fauzia, 2022; Indartanti & Kartini, 2014).

The relationship between iron and haemoglobin has been widely described. For iron absorption to occur effectively, an acidic atmosphere and reductants are required. For example, vitamin C (Lewa, 2017). The presence of vitamin C will create an acidic environment that facilitates the reduction of ferric iron to ferrous iron (Reka et al., 2016; Baha et al., 2021). Ferro will be more easily absorbed by the small intestine. The intestine absorbs about 19 to 15% of iron from the food consumed. During growth and in daily life, such as during menstruation, the amount of iron estimated to be released by the body is 0.4-0.5 mg/day. So, at least women release about 30 mg of iron every month due to the menstrual process. So, additional supplements such as iron supplements are important to maintain iron levels in the body and prevent iron deficiency anaemia (Taruna et al., 2023; Soedijanto et al., 2015).

An interventional study that combined the administration of iron and protein showed a greater increase in haemoglobin than an isolated intervention. About 200 mg iron tablets, when consumed together with adequate protein intake, may elevate haemoglobin by 1.55 g/dL over 30 days (Harahap et al., 2023). There are some recommendations for increasing the hemoglobin that may prevent anemia, a low-dose oral iron supplementation (<5 mg/kg/day) for 3-6 months depending on hemoglobin level, ensure the protein intake ≥1 g/kg/day to enhance the iron absorption and particularly can be found in meat or legumes, also a combined interventions of iron and protein may maximize the hemoglobin recovery (Erningtyas et al., 2022; Harahap et al., 2023; Lewa, 2017; Rehmat et al., 2025).

Depleted iron stores may precede anaemia, which is characterised by a lower level of haemoglobin (DeLoughery, 2017). Iron plays a role in integrating protoporphyrin IX into heme, and this process is facilitated by an enzyme in the mitochondria (Finch, 1958). An animal protein source, such as meat and fish, contains heme iron that may be absorbed 2-3 times more efficiently than non-heme plant iron. Because of protein aid to the iron regulatory enzymes, iron may be liberated from heme in the intestines (Finch, 1958; Nurjannah et al., 2021). Iron and protein intake have interdependent determinants for haemoglobin synthesis. While iron is a foundational element for heme synthesis, protein has a role in facilitating iron absorption and improving the bioavailability.

Conclusion

This study showed no significant correlation between iron intake and protein intake with haemoglobin levels in students of the Faculty of Medicine, The University of Mataram. Several factors are involved in the digestion of iron and protein. Moreover, some people have maintained normal haemoglobin levels because the body still has spare iron and protein. Further investigation into the factors involved in iron and protein intake may suggest new directions for other research.

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