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THE RELATIONSHIP BETWEEN BODY MASS INDEX AND HEMOGLOBIN LEVELS AND ITS ASSOCIATION WITH EMPLOYEE FITNESS STATUS

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Abstract

Anemia is a common health problem and is often related to a person's nutritional status. This study aims to analyze the relationship between Body Mass Index (BMI) with hemoglobin (Hb) levels and its implications for the fitness status of employees. This study used a cross-sectional design with 36 employees as respondents. Data were collected through direct measurement of BMI, Hb levels using the Easy Touch GCHb tool, and fitness status with the Harvard Step Test. Analysis was conducted using the Chi-Square test. The results showed that the majority of respondents had low Hb levels (55.6%), obese BMI (52.8%), and inadeqaute fitness status (55.5%). There was a significant relationship between gender and Hb levels (p=0.003) and between BMI and Hb levels (p=0.048). However, there was no significant relationship between Hb level and fitness status (p=0.660). These findings suggest that BMI and gender affect hemoglobin levels, but hemoglobin levels are not directly related to physical fitness levels. Understanding the relationship between nutritional status and Hb levels is important for anemia prevention and fitness improvement.

Keywords: Hemoglobin, Body Mass Index, Physical Fitness, Anemia

Introduction

Anemia is a condition where there is a decrease in the number of red blood cells so that they are unable to meet the oxygen needs of peripheral tissues. On clinical examination, anemia can be identified through measurement of hemoglobin, hematocrit, or red blood cell count, but usually the most commonly used hemoglobin measurement (1). According to WHO, nutritional anemia occurs when a person's hemoglobin level is less than 12 g/dL in women and less than 13 g/dL in men (2).

Anemia is a serious global public health problem that primarily affects young children, menstruating girls and pregnant and postpartum women. WHO estimates that 40% of children aged 6-59 months, 37% of pregnant women, and 30% of women aged 15-49 years worldwide are anemic (3). Riskesdas data in 2018, states that 32% of adolescents experience anemia, which means 3-4 out of 10 adolescents experience the condition. More than 80% of adolescent girls (15-24 years old) were also diagnosed with anemia. Factors that influence the condition are inadequate nutritional intake and lack of physical activity (4).

The causes of anemia are complex and the role of different determinants may vary from situation to situation. The prevalence and distribution of anemia is influenced by a wide range of factors, including biological, socio-economic, and contextual/ecological factors, with many factors acting simultaneously (5). There is evidence that Body Mass Index (BMI) may be associated with the

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incidence of anemia, although the direction of this relationship needs further investigation. Some studies have shown that the higher a person's BMI, the higher their hemoglobin levels, resulting in a decreased risk of anemia (6,7). However, other studies have found the opposite, women who are overweight or obese tend to have a higher chance of anemia (8,9). In fact, there are also studies that did not find any relationship between BMI and anemia (10). Studies that suggest obesity increases the risk of anemia usually attribute it to the chronic inflammation that occurs as a result of being overweight. This inflammation is thought to interfere with iron metabolism (11).

The relationship between iron deficiency anemia and physical work has been proven in many studies. Anemia can reduce the body's ability to perform physical activities, due to two main reasons: iron deficiency interferes with the ability of body tissues to use oxygen optimally and the lack of red blood cells inhibits the transportation of oxygen throughout the body. As a result, the body becomes tired more easily because the aerobic ability decreases, and the immune system is also disturbed. This certainly has a big impact, especially in a work environment that demands high physical activity (12,13). Mild anemia has also been shown to reduce performance in short to medium distance running, and similar aerobic exercises (14).

It is important to analyze the relationship between BMI and Hb levels and its association with physical fitness. An in-depth understanding of the relationship between the three can provide a basis for prevention and early treatment of health problems, especially those related to nutrition and fitness in employees at University X.

Methods

This study is a descriptive quantitative type using a cross-sectional approach in which data on independent and dependent variables are taken at the same time. The research was conducted at University X, in May 2025 with a population of all employees and a sample of employees who were present at the time of measurement of Hemoglobin (Hb) levels, fitness status and BMI with a total of 36 respondents. Measurement of BMI using digital scales and microtoise, measurement of Hb levels using Easy Touch GCHb, while measurement of fitness status using the Harvard Step Test. The sampling technique used was total sampling because the amount of data available was less than 100. Data were analyzed using descriptive Chi-Square analytics. Approval for this study was obtained from the ethics committee of the Faculty of Public Health, Universitas Sriwijaya.

Results

The following table represents the sample data of 36 respondents who came for examination. The data were characterized by gender, hemoglobin level, BMI measurement results and Fitness Status.

Table 1. Frequency Distribution of Gender, Anemia Status, BMI and Fitness Status

Characteristics	Frequency	%
Gender		
a. Male	11	30,6
b. Female	25	69,4
Hb Level		
a. Normal	16	44,4
b. Low	20	55,6
BMI		
a. Normal	17	47,2
b. Obese	19	52,8
Fitness Status		
a. Good	1	2,7
b. Moderate	15	41,7
c. Inadequate	20	55,5

Source: Primary Data 2025

Based on table 1 above, the majority of respondents who came at the time of data collection were female, 25 people (69.4%). Among the 36 total samples, 20 respondents had low Hb levels (55.6%), BMI in the obese category of 19 respondents (52.8%) and inadequate fitness status of 20 respondents (55.5%).

Table 2. Relationship between Gender and BMI with Hb Levels

Variable	Category	Hb Level				PR	PR (95% CI)	*p-value*
		Normal		Low				
		n	%	n	%			
Gender	Male	9	81,9	2	18,1	11,57	1,99-67,49	0,003
	Female	7	28	18	72			
BMI	Normal	11	64,7	5	26,3	5,13	1,23-21,35	0,048
	Obese	6	35,3	14	73,7			

Source: Primary Data 2025

Based on table 2 above, it was found that 18 female respondents had low Hb levels (72%). These results show that gender is significantly associated with Hb levels (PR=11.57; 95% CI =1.99-67.49; p-value=0.003). Table 2 also shows that out of 36 respondents, 14 respondents with obese BMI had low Hb levels (73.7%). These results indicate that BMI is significantly associated with Hb levels (PR=5.13; CI 95%=1.23-21.35; p-value=0.048).

Table 3. Relationship between Hb Level and Fitness Status

Variable	Category	Fitness Status						*p-value*
		Good		Moderate		Inadequate		
		n	%	n	%	n	100	
Hb Level	Normal	0	0	7	46,7	9	45	0,660
	Low	1	100	8	53,3	11	55	

Source: Primary Data 2025

Based on table 3 above, it was found that 11 respondents with low Hb levels had inadequate fitness status (55%). These results show that Hb levels are not associated with fitness status (p-value=0.660).

Discussion

Hemoglobin (Hb) is a protein in the blood that plays a role in transporting oxygen from the lungs to the rest of the body. Anemia is a major public health problem in women of reproductive age, due to increased iron requirements during pregnancy, breastfeeding, menstrual bleeding, as well as nutritional deficiencies that can occur throughout their reproductive cycle (15). Seeing the high prevalence of anemia, especially in vulnerable groups, it is important to understand the various factors that can affect anemia status, one of which is nutritional status measured through Body Mass Index (BMI). The relationship between BMI and anemia is still debatable. Some studies show that anemia is associated with high BMI (16). The cause is thought to be related to inadequate iron intake and inflammation due to fat cells, although the exact cause has yet to be determined. In contrast, some other studies have shown a high incidence of anemia in individuals with low BMI (underweight), while the incidence of anemia is relatively low in obese individuals (6,10). One health status factor that affects physical fitness is anemia. Anemia occurs when the hemoglobin level in the body is less than 12 g/dL. The formation of hemoglobin in the blood becomes not optimal due to iron deficiency (17).

The results showed that there was a significant relationship between female gender and low Hb levels. Women are more at risk of anemia than men. The difference between men and women is likely due to the different underlying mechanisms of anemia. In women, the main cause of anemia is iron deficiency, which generally occurs due to menstrual bleeding and insufficient dietary iron intake (18). Unlike women, anemia in men is generally not caused by physiological processes such as blood loss, but is more often an indication of an underlying chronic disease (18) that can have a different effect on physical ability or endurance.

In addition to gender, the results of the study also showed a significant relationship between BMI and Hb levels. Hamed et al., (2024) in their study mentioned that the prevalence of anemia was higher among overweight respondents compared to those who were obese and normal (19). Individuals with overweight to obesity show that the higher a person's body weight, the greater the impact on iron levels in the body. Meta-analysis research results show that obese individuals experience more significant changes in iron levels and have a higher risk of iron deficiency compared to those who are only overweight (20). The exact causes of iron deficiency in obese individuals are not yet fully understood. Previous hypotheses include: unhealthy eating patterns, higher iron requirements due to larger body size, reduced physical activity leading to lower levels of myoglobin (a protein that stores iron in muscles), or genetic factors (21,22).

The theory explaining the relationship between iron deficiency and obesity states that people with obesity tend to experience systemic inflammation which results in increased production of hepsidin, a hormone that inhibits iron absorption in the intestine and lowers blood iron levels by destroying feroportin, an iron transport channel in intestinal cells. Obesity also affects various pathways in the body involved in iron regulation, thereby reducing the availability of iron for the body to use (23,24). In contrast, a study in 2024 showed that there was a positive correlation between BMI and hemoglobin levels in women aged 15-49 years. Women with very underweight and underweight were found to be at higher risk of anemia than women with normal weight (25).

Furthermore, the results showed no significant relationship between Hb levels and fitness status. Other studies have shown that on the contrary, hemoglobin levels have a 1.73 times greater effect on physical fitness. All body tissues obtain oxygen from the lungs with the help of hemoglobin, which acts as an oxygen transporter. This oxygen is then utilized as fuel in the process of energy metabolism. When

hemoglobin levels in the body are sufficient and able to bind oxygen optimally, the aerobic metabolic process will take place properly, so that the body can produce the energy needed for activity. Low hemoglobin levels can lead to a decrease in a person's physical ability or working power. Conversely, having normal hemoglobin levels can support the achievement of an optimal level of physical fitness (26).

This study has several limitations, including a small sample size, other factors that can affect hemoglobin levels and fitness, such as iron intake, physical activity, and menstrual status in women, were not controlled. The use of portable hemoglobin meters also has accuracy limitations compared to laboratory methods and the measurement of fitness using the Harvard Step Test is still general and does not reflect all aspects of physical fitness. Nevertheless, this study still makes an important contribution to understanding the relationship between nutritional status and hemoglobin levels and its implications for employees' physical fitness.

Conclusion

This study shows that there is a significant relationship between gender and Body Mass Index (BMI) with hemoglobin (Hb) levels among employees at X University. More female respondents were found to have low Hb levels than males, and respondents with obese BMI also had a higher risk of anemia. This indicates that biological factors and nutritional status play an important role in determining a person's hemoglobin status. However, the results of the study did not find a significant relationship between hemoglobin levels and physical fitness status, although theoretically low Hb levels may result in decreased physical ability. This finding underscores the importance of monitoring nutritional status, especially in vulnerable groups such as women with abnormal BMI. Appropriate nutrition interventions and promotive efforts to maintain ideal body weight and prevent anemia need to be carried out regularly in the work environment. As a follow-up effort, it is recommended that institutions conduct routine checks of hemoglobin levels and BMI as part of employee health monitoring. Nutrition education and promotion of a healthy lifestyle need to be improved to prevent anemia and maintain physical fitness. Further research with a wider scope and considering factors such as diet and physical activity is also recommended to strengthen these findings.

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