

The Association Body Mass Index with the Incidence of Anaemia Among Students

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Abstract: Anaemia among teenagers is a significant public health concern that can adversely affect their quality of life, cognitive function, and academic performance. Nutritional status, commonly assessed using Body Mass Index (BMI), is suspected to influence the risk of developing anaemia. This study aims to analyse the relationship between BMI and the incidence of anaemia among students at Senior High School II Rilamuta. The primary objective is to determine whether there is a statistically significant association between BMI and anaemia occurrence in this population. A quantitative correlational research design was employed, involving a purposive sample of 30 students. Data collection comprised measuring each student's BMI and examining haemoglobin levels to assess anaemia status. The BMI was calculated based on height and weight measurements, while haemoglobin concentrations were measured using standard clinical laboratory techniques. Statistical analysis was performed using the Pearson correlation test to evaluate the strength and direction of the relationship between BMI and anaemia incidence. The results revealed a significant positive correlation between BMI and anaemia, with a Pearson correlation coefficient of 0.746 and a p-value of 0.000, indicating strong statistical significance. This finding suggests that students with higher BMI tend to have a lower risk of anaemia, highlighting the protective role of adequate nutritional status. The study confirms that BMI is a relevant factor in predicting anaemia risk among teenagers. Based on these findings, the study recommends promoting healthy nutritional habits and improving nutritional status as crucial strategies to prevent anaemia in school-aged adolescents. School health programs should emphasize balanced diets and nutritional education to address this issue effectively. Future research with larger sample sizes and longitudinal designs is encouraged to further explore causal relationships and additional factors influencing anaemia in this population.

Keywords: Anaemia, BMI, Students

1. Introduction

Anaemia is one of the health problems commonly found among teenagers, especially in developing countries like Indonesia. Anaemia is a condition in which the body experiences a deficiency of haemoglobin or red blood cells, leading to a decrease in the blood's capacity to carry oxygen throughout the body (Oh et al., 2020). This condition can result in various negative impacts, such as fatigue, decreased concentration, and even growth and developmental disorders. In teenagers, anaemia can affect academic performance, immune resistance, and overall productivity (Sartika et al., 2021).

One of the factors contributing to the occurrence of anaemia is nutritional status, which can be measured through the Body Mass Index (BMI). BMI is a commonly used indicator to determine an individual's nutritional status based on the comparison between weight and height. Based on the classification provided by the World Health Organization (WHO), BMI is divided into several categories: undernutrition, normal, overweight, and obesity.

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Imbalances in nutritional status, whether in the form of underweight or overweight, can affect the risk of anaemia (Amriyati et al., 2023).

In teenager, nutritional deficiencies are often associated with low intake of iron, protein, and vitamins needed for red blood cell production. Teenager with low BMI tend to have insufficient nutrient intake, causing their bodies to be unable to produce enough haemoglobin (Barffour et al., 2019). Conversely, being overweight or obese can also contribute to anaemia through chronic inflammatory mechanisms that inhibit iron absorption and affect red blood cell production.

The prevalence of anaemia in Indonesia is still quite high. According to data from the 2018 Basic Health Research (Riskesdas), the prevalence of anaemia among teenager in Indonesia reaches 32%, meaning nearly one in three teenager experience this condition. The contributing factors vary, ranging from unhealthy eating patterns, insufficient intake of iron-rich foods, to lifestyle habits that are not supportive of health. Other factors such as heavy menstruation in teenage girls also increase the risk of anaemia, due to significant blood loss every month.

The Senior High School II Rilamuta is one of the schools in an area where the level of nutrition awareness still needs improvement. Many students at this school do not yet have a sufficient understanding of the importance of balanced nutritional intake to prevent anaemia. As an educational institution, schools play a vital role in raising students' awareness about the importance of healthy eating patterns and optimal nutritional status. Therefore, it is important to examine the relationship between BMI and the incidence of anaemia among students at Senior High School II Rilamuta as an effort to understand the pattern of anaemia occurrences and to develop prevention strategies.

Research on the relationship between BMI and the incidence of anaemia has been extensively conducted in various countries. Several studies have shown a significant relationship between nutritional status and haemoglobin levels in the blood. For instance, research conducted in India found that teenager with low body weight have a higher risk of anaemia compared to those with normal nutritional status. Similar studies in Indonesia also indicate that poor dietary patterns and unbalanced nutritional intake contribute to the high incidence of anaemia among teenager.

Anaemia can have long-term effects on an individual's health. Teenagers who experience anaemia are at risk of a reduced quality of life, fatigue, and greater susceptibility to infections. Furthermore, in the long term, anaemia in teenage girls can impact maternal and child health in the future. Therefore, understanding the risk factors for anaemia at an early stage is an important step in the prevention and control of anaemia in the community.

In addition to nutritional factors, lifestyle also plays an important role in the occurrence of anaemia. Unhealthy eating habits, such as consuming fast food that is low in iron, a lack of consumption of green vegetables and red meat, and the habit of drinking tea or coffee

after meals can inhibit the absorption of iron in the body. On the other hand, regular exercise can help improve blood circulation and increase haemoglobin levels.

The eating habits and lifestyles of students at this school still vary, with most students not having a full awareness of the importance of a healthy diet. Some students have irregular breakfast habits, while others often consume instant food instead of balanced nutritious meals. Therefore, this study is also expected to provide recommendations regarding the importance of nutrition education among students to reduce the incidence of anaemia. The main objective of this research is to analyse the association between BMI and the incidence of anaemia among students at Senior High School II Rilamuta.

2. Proposed Method

This study is a quantitative research with a cross-sectional design aimed at analysing the association between BMI and the incidence of anaemia at Senior High School II Rilamuta. This design allows for data collection at a single point in time to identify patterns and relationships between variables. The research was conducted at Senior High School II Rilamuta, Boalemo Regency, Sulawesi. The research period was carried out from May to June 2024. The population in this study is all students of Senior High School II Rilamuta as many as 30 people. The sample was selected using purposive sampling techniques with inclusion criteria being students who were willing to participate in the study, did not have a history of chronic illness affecting haemoglobin status, and had complete data regarding BMI and haemoglobin levels. Exclusion criteria included students who were regularly consuming iron supplements or had certain medical conditions that could interfere with the study results. Data was collected through BMI measurements using digital scales and a stadiometer, as well as hemoglobin level assessments using a hemoglobinometer. Additional data regarding students' dietary patterns and lifestyle habits was gathered through structured questionnaires. The data was analysed using Pearson correlation tests to assess the relationship between BMI and the incidence of anaemia. Data processing was performed with statistical software, with a significance level set at $p < 0.05$. The analysis results were used to provide recommendations for efforts to prevent anaemia in the school environment.

3. Results and Discussion

Table 1. Frequency Distribution of BMI

Body Mass Index	Frequency (f)	Percentage (%)
<18.5 (Malnutrition)	7	23.3
18.5-24.9 (Normal)	16	53.3
≥25 (Overweight)	7	23.3
Total	30	100.0

Based on Table 1, the majority of respondents have a BMI in the normal category (53.3%), while 23.3% of respondents are in the malnutrition category and 23.3% are in the overweight category.

Table 2. Frequency Distribution of the Incidence of Anaemia in Respondents

The Incidence of Anaemia	Frequency (f)	Percentage (%)
< 12 g/ dl (Anaemia)	15	50.0
≥12 g/dl (Normal)	15	50.0
Total	30	100.0

Base on table 2, it can be seen that 50% of the respondents experienced anaemia, while the other 50% had haemoglobin levels within the normal range.

Table 3. Cross Tabulation of Body Mass Index with the Incidence of Anaemia

Body Mass Index	The Incidence of Anaemia				Total	
	Anaemia		Normal		Frequency (f)	Percentage (%)
	Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)		
<18.5 (Malnutrition)	6	20.0	1	3.3	7	23.3
18.5-24.9 (Normal)	6	20.0	10	33.3	16	53.3
≥25 (Overweight)	3	10.0	4	13.4		23.4
Total	15	50.0	15	50.0	15	100.0

Base on table 3 shows that the incidence of anaemia is more frequently found in respondents with a BMI category of malnutrition (20%) and normal (20%), whereas in the overweight category, 10% experienced anaemia.

Table 4. Pearson Correlation Test Results between Body Mass Index with the Incidence of Anaemia

Variables	Pearson Correlation	P (α 0.05)
Body Mass Index with the Incidence of Anaemia	0.746	0.000

Based on the statistical test results in Table 4, a Pearson correlation value of 0.746 was obtained with a p-value of 0.000. This indicates that there is a significant relationship between BMI and the occurrence of anaemia in the respondents. Thus, this study indicates that nutritional status, measured through BMI, has a significant relationship with the incidence of anaemia among students at Senior High School II Rilamuta. Students with low BMI (malnutrition) are at a higher risk of experiencing anaemia compared to those with normal or higher BMI. Therefore, efforts to improve nutritional status through healthy dietary practices and nutrition education need to be emphasized to prevent anaemia among school-aged teenager.

4. Discussion

The results of this study indicate that there is a significant relationship between Body Mass Index (BMI) and the incidence of anaemia among students at Senior High School II Rilamuta. Based on the statistical analysis conducted, a Pearson correlation value of 0.746 was obtained with a p-value of 0.000, indicating a strong positive relationship between the two variables. These findings are consistent with various previous studies that show that a person's nutritional status, as measured by BMI, has an effect on haemoglobin levels in the blood.

Anaemia is a condition characterised by low haemoglobin levels in the blood, which can be caused by various factors, including poor nutritional status. An unbalanced nutritional status, whether in the form of underweight or overweight, can contribute to an increased risk of anaemia. In this study, the majority of respondents with a low BMI experienced anaemia, which indicates that insufficient nutrition can affect red blood cell production. This can be explained by low intake of iron, protein, and vitamins in individuals with underweight, which are crucial for haemoglobin synthesis.

Conversely, students with a higher BMI or obesity also tend to experience anaemia, although in smaller numbers compared to those with a low BMI. This condition may be caused by chronic inflammation occurring in obese individuals, which can hinder iron absorption in the body. Previous studies have shown that obesity can trigger an increase in hepcidin levels, a hormone that regulates iron balance in the body (Suandana et al., 2023). An increase in hepcidin can lead to decreased iron absorption, thus increasing the risk of anaemia even if a person has sufficient iron reserves in their body (Kaban, 2023).

The results of this study show that students with a low Body Mass Index (BMI) have a higher prevalence of anaemia compared to those with a normal BMI. This can be linked to a lack of iron intake in their daily diet. Iron is a key component of haemoglobin, which functions in the transport of oxygen throughout the body. Inadequate iron intake will lead to a decrease in haemoglobin production, which ultimately increases the risk of anaemia (Amalia & Meikawati, 2024).

Teenagers with a low BMI often experience nutritional deficiencies, including insufficient consumption of iron-rich foods such as red meat, liver, green vegetables, and legumes. Iron deficiency in the body can hinder the formation of red blood cells, which leads to suboptimal oxygen supply to vital organs (Natasha & Suparti, 2024). As a result, teenagers with anaemia are more prone to fatigue, dizziness, and difficulty concentrating, which in turn can negatively impact their academic performance and quality of life.

In Indonesia, an unbalanced diet remains a major issue in the nutritional status of adolescents. Many teenagers prefer high-calorie foods that are low in iron, such as fast food, soft drinks, and processed foods. This habit is exacerbated by a low awareness of the importance of a healthy diet. Additionally, the consumption of beverages such as tea and coffee after meals can hinder the absorption of iron in the body. Tea and coffee contain tannins that can bind with non-heme iron from plants, thereby reducing the effectiveness of

its absorption by the body (Istiningsih & Meyasa, 2024). Therefore, this habit should be reduced, especially for those who are already at risk of developing anaemia.

In addition to improving eating habits, the role of nutrition education is also very important in raising adolescents' awareness of the significance of iron consumption. Schools can play an active role in providing information on balanced nutrition and the importance of consuming iron-rich foods. Health education programmes, such as nutrition campaigns and the provision of iron supplements for students at high risk of anaemia, can be a strategic step in preventing and reducing the incidence of anaemia among adolescents (Bujani et al., 2023).

Anaemia has a wide-ranging impact on an individual's health and productivity, especially among adolescents. A decrease in haemoglobin levels in the blood can lead to various symptoms, such as fatigue, dizziness, difficulty concentrating, and a weakened immune system. Adolescents with anaemia often feel weak and fatigued, making it difficult for them to actively participate in school learning activities (Wahyuni & Syamiyah, 2024). This condition results in them having less focus in understanding lesson material, experiencing difficulties in remembering information, and becoming more easily demotivated in their studies.

Previous research has shown that anaemia in teenagers is associated with lower cognitive abilities, which can directly impact their academic performance (Handayani & Sugiarsih, 2022). A study conducted in several schools in Indonesia found that students with anaemia had lower academic scores compared to those with normal haemoglobin levels (Renny Adelia Tarigan et al., 2022). This is due to the lack of oxygen received by the brain, which hinders cognitive function and memory. A shortage of oxygen in the brain can slow down thinking processes and decision-making, making students with anaemia tend to be slower in grasping lessons compared to their peers with normal haemoglobin levels.

In addition, anaemia can also cause sleep disturbances in teenagers. Several studies have shown that individuals experiencing anaemia often suffer from sleep disturbances, such as insomnia or restless sleep. These sleep disturbances will further worsen their physical and mental condition, as lack of sleep can lead to concentration problems, decreased memory, and an increased risk of stress and anxiety (Rizki Fauzan et al., 2022).

Prevention of anaemia in adolescents can be achieved through improvements in diet and the adoption of a healthy lifestyle. One of the main ways to prevent anaemia is by ensuring adequate iron intake in daily dietary patterns. Iron is an essential nutrient that plays a role in the production of haemoglobin, a protein in red blood cells responsible for transporting oxygen throughout the body (Zaini Miftach, 2018). In addition to diet, a healthy lifestyle also plays an important role in the prevention of anaemia. Sufficient physical activity, such as regular exercise, can help increase the production of red blood cells and improve blood circulation (Rodiyah, 2022). Recommended exercises include aerobic activities such as running, swimming, or cycling, which can enhance lung capacity and the efficiency of oxygen

transport in the blood. By exercising regularly, the body can be more effective in producing red blood cells, thereby minimising the risk of anaemia.

In addition, sufficient sleep habits also play a role in maintaining blood health. Quality sleep aids the body in the process of cell regeneration, including red blood cells. Teenagers who do not get enough sleep often experience chronic fatigue, which can worsen the condition of anaemia. Therefore, it is important for teenagers to get enough sleep, around 7–9 hours per night, for the body to function optimally (Paramudita et al., 2021).

Nutrition education programmes can be carried out in various ways, such as routine counselling by health workers, the inclusion of health modules in the curriculum, and nutrition campaigns in the school environment (Vira et al., 2024). Students should be educated on the importance of iron in the formation of haemoglobin and the negative impact of anaemia on their health and academic performance. With good nutrition education, students can better understand that a balanced diet greatly affects their energy and concentration during learning activities. This education should also involve parents and teachers, as support from the surrounding environment is crucial in fostering healthy eating habits in children (Kusuma et al., 2023).

Early detection of anaemia is very important to prevent further negative impacts on students' health. Therefore, schools can collaborate with health centres or community health clinics to conduct regular haemoglobin level checks. This examination can help identify students at risk of developing anaemia, so they can be promptly provided with appropriate interventions (Seliawati et al., 2023). This check can also be combined with iron supplement programmes for students in need. Several studies indicate that providing iron tablets (ITD) to adolescent girls regularly can help prevent anaemia due to blood loss during menstruation (Regita et al., 2024). This programme has been implemented in several schools in Indonesia and has proven effective in reducing incidence rates.

5. Conclusions

The results of this study indicate a significant relationship between BMI and the incidence of anaemia among students at SMAN 2 Rilamuta. Students with a low BMI have a higher risk of developing anaemia compared to those with a normal BMI. However, students with a high BMI or obesity are not entirely free from the risk of anaemia due to inflammatory factors that can affect iron absorption in the body. This research has important implications for efforts to prevent anaemia among adolescents. School-based interventions, such as nutrition education, provision of healthy food, and regular health check-ups, can be strategic steps in reducing the incidence of anaemia.

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