ORIGINAL ARTICLE

Application of the Health Belief Model (HBM) in Understanding the Relationship Between Anemia and Academic Performance Among Junior High School Students in Lhokseumawe City, Indonesia

Application du modèle de croyance en matière de santé (HBM) pour comprendre la relation entre l'anémie et les performances scolaires chez les élèves du premier cycle du secondaire de la ville de Lhokseumawe, en Indonésie

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Abstract

Introduction: Indonesia ministry of health data shows that 21.7% of the population has anemia, with a prevalence of 26.4% in the 5–14-year age group and 18.4% in the 15–24-year age group (Hb <12.0 g/dL). The Health Belief Model (HBM) is used to identify lifestyle patterns of anemic students and their risks to academic achievement.

Aims: This study examines the relationship between hemoglobin levels and academic achievement and assesses the relationship between the HBM construct and anemia.

Methodology: This study is a cross-sectional study with a sample of 80 grade VIII students at SMP Negeri 1 Lhokseumawe. This study examines the relationship between hemoglobin levels and academic achievement and assesses the relationship between the HBM construct and anemia

Results: Chi-square test showed a significant relationship ($p<0.05$) between anemia and academic achievement, where students with normal hemoglobin levels had better achievements than those with anemia.

Conclusions: These findings confirm the impact of anemia on academic achievement, highlighting the importance of iron for brain function, concentration, and intelligence. The limited correlation of most HBM constructs with anemia suggests low student awareness, thus educational interventions are needed to improve preventive behavior.

Key-words: Anemia, academic achievement, HBM

Résumé

Introduction: Les données du ministère indonésien de la Santé indiquent que 21,7 % de la population souffre d'anémie, avec une prévalence de 26,4 % chez les 5-14 ans et de 18,4 % chez les 15-24 ans (Hb < 12,0 g/dL). Le modèle de croyances en matière de santé (MBS) est utilisé pour identifier les modes de vie des élèves anémiques et leurs risques pour la réussite scolaire.

Objectifs : Cette étude examine la relation entre le taux d'hémoglobine et la réussite scolaire, et évalue la relation entre le modèle MBS et l'anémie.

Méthodologie : Il s'agit d'une étude transversale portant sur un échantillon de 80 élèves de 8e année de l'école secondaire SMP Negeri 1 de Lhokseumawe. Cette étude examine la relation entre le taux d'hémoglobine et la réussite scolaire, et évalue la relation entre le concept HBM et l'anémie.

Résultats : Le test du khi carré a montré une relation significative ($p < 0,05$) entre l'anémie et la réussite scolaire, les élèves présentant un taux d'hémoglobine normal obtenant de meilleurs résultats que ceux anémiques.

Conclusions : Ces résultats confirment l'impact de l'anémie sur la réussite scolaire, soulignant l'importance du fer pour le fonctionnement cérébral, la concentration et l'intelligence. La corrélation limitée de la plupart des concepts HBM avec l'anémie suggère une faible sensibilisation des élèves; des interventions éducatives sont donc nécessaires pour améliorer les comportements préventifs.

Mots clés : Anémie ; Performance scolaire ; Modèle de croyance en matière de santé

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Introduction

Anemia is one of the most widespread and difficult nutritional issues in the world. It is not specific to any region of the world, whether rich or poor, at the individual level. Rather, it affects the health of the people and social and economic progress of any country. The World Health Organization (WHO) suggests that there are about two billion people suffering from anemia in the world. In roughly half of those cases, the deficiency of iron is the main cause. At any age, iron deficiency anemia can occur, but it is very Common in pregnant women and young children. It is also true for older children, particularly adolescent girls. The 2002 World Health Report claimed that for countries with infant and maternal mortality rates there had, iron deficiency anemia was one of the top ten most dangerous health concerns. Furthermore, public health measures aimed at reducing iron deficiency anemia have been found to have the highest economic returns for the investments made.1

Based on the Basic Health Research (Riskesdas) Report in 2013, 21.7% of the population of Indonesia is identified as having subnormal levels of hemoglobin. This figure encompasses 20.6% for urban areas, 22.8% for rural regions, 18.4% for males and 23.9% for females. Of various age brackets, 28.1% of toddlers have values below 110g/dL, 26.4% 5 to 14 years children have values below 120 g/dL, and 18.4% of 15 to 24 years old adolescents have values below 120 g/dL, along with 37.1% pregnant women who are diagnosed as anemic. The 2018 Basic Health Research reported the cases of anemia in adolescents, increasing by 32%.1-3

Anemia is a condition marked by a concerning reduction in the hemoglobin (Hb) component of blood. Due to monthly menstruation and growth spurts needing higher iron intake, female adolescents tend to suffer from it ten times more than male adolescents. In adolescents, the cut-off level for diagnosing anemia is hemoglobin lower than 12g/dL.1,2

Both anemia and iron deficiency may result in lower enthusiasm and concentration levels, which can negatively affect academic performance and work productivity. In comparison to healthy children, these disorders have lower psychomotor development and academic achievement.4,5

Academic achievement is the composite of different parameters of the learning process traditionally represented in grades for different subjects by educators. It shows the accumulated performance of students in the set period of studying which is expected to bring about changes in behavior, knowledge, and skills. These changes are objective and quantifiable.6,7

Academic achievement can be assessed in a systematic manner using instruments called achievement tests, which assess the maximum level of mastery the subjects can achieve of the taught material. These include performance in class, which consists of daily quizzes, formative tests, summative tests, and even the entrance exams to the university.8

The determinants behind low hemoglobin levels must also be examined to avert disease and can be related to the Health Belief Model (HBM). Health beliefs are associated with a person's readiness to take action to avoid disease and HBM was constructed in the 1950s to explain why people often fail to follow preventative measures within a health framework. The model has since evolved and been adapted for broader applications related to individual preventive health actions. The primary theory behind the HBM is that health behavior is a direct function of the individual's beliefs or perceptions of the disease and the remedies existing to avert it.9

HBM rests on four concepts: perceived susceptibility, perceived severity, perceived benefit, and perceived barrier. Perceived susceptibility is an individual's conception regarding his or her chances of being infected by a disease. Perceived severity encompasses an individual's ideas on the seriousness of a disease or diagnosed condition which is often accompanied by various degrees of physical consequences (example: death, disability, pain) and social consequences (example: inability to function in society, difficulties in building relationships, and being stigmatized). Perceived benefit is defined as an individual's belief in the positive outcomes of an action that may mitigate the possibility of being affected by a disease, including positive health effects and saving expenses. A perceived barrier is defined as a person's evaluation of the challenges they may face, such as social, financial, and physical, when attempting to practice recommended health behaviors.10

HBM is a model that concentrates on the individual actions that one undertakes in relation to a health problem and how they believe those actions will affect a given health condition. Use of healthcare facilities and protective behaviors are some of the actions that may be taken. HBM has a broad application in the study for the understanding and the analysis of the human health behavior in a specific society.11

The central tenet of HBM argues that any health action is motivated by how an individual views the illness and the possible actions they may take toward averting it. In other words, HBM seeks to account for the ways individuals interpret their observance of health and disease and strive toward effecting a state of health or eliminating disease. According to the model, the combination of an individual's perception of being vulnerable to a disease with believing in the serious consequences of that disease describes the measures (perceived severity) that motivates an individual. All these individual perceptions produce an assumed threat that incites a person to take steps to prevent disease and seek health examination.12

HBM has been used with different communicable diseases and even in the prevention of COVID-19. It is regarded as useful in addressing perceived barriers to enable self-efficacy to cope with the healthy behavior. HBM can be adapted to explore both short-term and long-term health behaviors.10

The application of HBM in this study aims to identify students' lifestyle behaviors and the impact of anemia on academic performance. Therefore, the identification and implementation of HBM are expected to help prevent anemia risk among junior high school students in Lhokseumawe City. The findings of this study are

expected to provide insights for developing preventive actions and mitigation strategies to reduce the decline in learning quality caused by low hemoglobin levels among students.

The objective of this study is to determine the prevalence of anemia among eighth-grade students at SMP Negeri 1 Lhokseumawe and evaluate its relationship with academic performance by analyzing hemoglobin levels and achievement metrics. Additionally, the study aims to assess students' perceptions of anemia through the application of the Health Belief Model (HBM), focusing on constructs such as perceived susceptibility, perceived severity, perceived barriers, and perceived benefits, and examine their association with anemia prevalence. This research is designed to be completed within a five-month period, from May to October 2024, utilizing a sample size of 80 students selected through a statistically rigorous method to ensure the validity and reliability of the findings.

Methods

Definition of Anemia

To achieve our goal, Global Accelerated Action for the Health of Adolescents (AA-HA!) Implementation Guidance since 2016-2030 was applied (table 1).

Table 1. Definition of Anemia

Group	Normal Limit
Toddlers	11gr/dL
School Age Children	12gr/dL
Adult Women	12gr/dL
Adult Men	13gr/dL
Pregnant Women	11gr/dL

WHO 2016

Samples

The type of research using the Cross-Sectional method. The Cross-Sectional method is a study that emphasizes the time of measurement or observation of independent and dependent variable data at only one time. The sampling technique in this study was carried out using simple random sampling, namely by taking samples by selecting directly from the population and the large opportunity for each member of the population to become a sample is very large.

This research relies on primary and secondary data sources. Grade 8 students of SMP Negeri 1 Lhokseumawe City who are willing to take part in learning provide hemoglobin results, achievement tests, questionnaires and report cards. Secondary data was obtained from agencies such as the Lhokseumawe City Education Office and Lhokseumawe City 1 Middle School which includes data on the number of schools with the lowest National Examination (UN) scores.

The sample in this study were students of class VIII of SMP Negeri 1 Lhokseumawe who met the inclusion and exclusion criteria.

The inclusion criteria were research subjects who could represent the research sample that met the requirements as a sample.

Inclusion criteria:

1. Active status and present as students of class VIII of SMP Negeri 1 Lhokseumawe.
2. Willing to be respondents and obtain parental approval by signing an informed consent.

Exclusion criteria:

1. Students with Thalassemia.
2. Students with Aplastic Anemia.
3. Students with malnutrition.

The population of this study consisted of 264 class VIII students of SMP Negeri 1, the sample size was calculated using the Slovin formula. The calculation results show that the minimum sample size that can represent the population in this study is 72.5274725 or rounded up to 73 students (minimum sample). To avoid data collection errors, the sample size was increased by 10% from the minimum to 80 students.

Data

Check Hb levels

Researchers used Dr. Family Tools. We do calibration before do the test. Hemoglobin Test Meter, this tool is a portable and practical tool for measuring a person's Hemoglobin (Hb) Levels. The equipment used to measure hemoglobin levels is a hemoglobin meter, hemoglobin test strips, 7 µL volume micro pipettes, lancing devices, lancets. The first way to measure hemoglobin levels is to calibrate the tool by inserting the Hb strip according to the code on the test strip bottle, turning on the tool until the gr/dL sign appears on the screen, inserting the test strip chip into the tool until you hear a "beep" sound and matching the code number on the bottle. test strip, insert the Hb level measurement strip into the Hb meter, insert a 7 µL blood sample into the Hb level measurement strip then wait 1-2 minutes to see the results obtained, read and record the measurement results.

Learning achievement is assessed in 3 ways:

Report card grades

Assessment by looking at the average report card grades for semesters 1-3.

Questionnaire

Questionnaire containing student achievement. This assessment instrument uses assessment provisions for each favorable statement answer given a value of (1) correct and a value of (0) No. Then the answer to the unfavorable statement is given a value of (0) as correct and a value (1) as not. The questionnaire containing student achievement in this study has 20 statements, positive statements (favorable), namely questions number 1, 2, 3, 4, 5, 6, 7, 9, 10, 12, 14, 16, 18, 19, 20 while the negative statements (unfavorable) are questions number 8, 11, 13, 15, 17.

Achievement test

The test instrument is in the form of multiple-choice

test questions in the subjects of Mathematics, Science, Indonesian and English to identify problem solving abilities consisting of 20 questions within 30 minutes. This assessment instrument uses assessment provisions: every correct answer is given a value (1) and incorrect answers are given a value (0). After getting the results from the three items above, the results of each respondent's answers will be added and divided by three, then the results of the respondent's answers will be calculated using the formula:

$$P = \frac{f}{N} x\ 100\%$$

Information:
P: Knowledge Percentage
f: Number of correct answers
N: Maximum number of scores
The interpretations used to assess respondents' knowledge:
1. Good (76-100%)
2. Fair (56-76%)
3. Less (< 56%)

In Indonesia, the term "junior high school" is referred to as "sekolah menengah pertama", abbreviated as SMP (hereafter, we will use the abbreviation SMP in this paper). According to initial survey data from the National Examination (UN) score list for junior high schools (SMP/MTs) for the 2015/2016 academic year from the Education, Youth, and Sports Department of Lhokseumawe City, SMP Negeri 1 Lhokseumawe had the lowest exam scores in the city. Specifically, the scores were 32 in Indonesian language, 48 in English, 20 in mathematics, and 43 in science. For the 2016/2017 academic year, SMP Negeri 1 Lhokseumawe again had the lowest exam scores in the city, with 26 in Indonesian language, 24 in English, 15 in mathematics, and 13 in science.
Based on initial survey data conducted by researchers at the Banda Sakti Public Health Center in Lhokseumawe City, from July to December 2024, 207 people underwent Hb tests, and 99 people, or about 47.83%, were found to have low Hb levels. This condition is likely to cause health problems, particularly a lack of concentration in learning among adolescent students.

HBM assessment
Health belief model assessment is a model that specifies how individuals cognitively demonstrate healthy behavior and efforts to achieve health or cure from an illness. There are 4 main concepts of this health belief model. 23,24 In the first concept, perceived susceptibility, in the second concept, Perceived severity, in the third concept, Perceived barriers, and in the fourth concept, Perceived benefits. Students will fill out a questionnaire containing 4 questions related to 4 HBM assessments with anemia. The question related to the first concept is how students perceive their risk of developing anemia. The second concept is related to how students understand the impact of anemia on health. The third concept asks whether students are aware of the benefits of consuming iron-rich foods to prevent anemia? Do they know good food sources? and the fourth concept asks Are there any obstacles preventing students from consuming iron-rich foods? For example, do they feel the food is expensive or difficult to find?
The interpretations used for assessing HBM with anemia:
1. Height: 4-5
2. Low: 1-3

Validity Test
Validity refers to how accurately the data collected by researchers represents real-world conditions. An instrument is valid if it measures what it is intended to measure. If a variable score has a strong correlation with the total score, then the question is valid. Question that cant be answered has to be corrected or eliminated. The validity test uses Karl Pearson's product-moment correlation formula, and the formula is as follows:

$$r_{xy} = \frac{N\ \sum XY - (\sum X)(\sum Y)}{\sqrt{\{N \sum X^2 - (\sum X^2)\}\{N \sum Y^2 - (\sum Y^2)\}}}$$

with the following criteria (table 2):
• If the calculated r-value is greater than the table r-value → Valid
• If the calculated r-value is smaller than the table r-value → Invalid

Table 2. Validity Test

Question number	r Correlation	Significant Value	Conclusion
1-12	0,519-0,863	0,05	Valid

Reliability Test
Reliability is one of the main characteristics or objects of a good measurement instrument. However, sometimes reliability is also referred to as accuracy, dependability, stability, and so on, but the main idea in the concept of reliability is the extent to which the results of a benchmark can be trusted, and that means the extent to which the measurement output is free from measurement error. The method used in this reliability test uses the Cronbach's Alpha method. If the Cronbach's Alpha value of the variable being studied is greater than the r table value, then the question item is reliable (table 3).

Table 3. Reliability Test for Variables

Variabel	Alpha Cronbach	Significant Value	Conclusion
Achievement Level and HBM	0,949	0,05	Reliable

Data Collection Procedure
Procedures begin with applying for a research permit at the educational office, which is directed to SMP Negeri 1 Lhokseumawe. Collection of the primary data progresses as follows: First, an ethical clearance request for the study is submitted. A pre and post reliability check of the questionnaire is done. After receiving the research permit letter, the researcher goes to SMP Negeri 1 Lhokseumawe. Simple random sampling is then employed to identify the research subjects. Upon arrival at the school, the researcher provides the data collection objectives and methods to be used. Data is captured from students who pass the criteria such as the informed consent, and

students who have semester report cards from 1-3. Blood tests for hemoglobin levels are done using the Family Dr. Hemoglobin Mter. Respondents are required to fill in the questionnaire and their responses are reviewed for adequacy. In addition, respondents are instructed to respond to the achievement test questionnaire and the answer sheet is checked after filled in. All information is compiled on the answer sheets and processed, analyzed, and formatted before being presented in table form.

Results

The data analysis process uses univariate analysis and bivariate analysis. Univariate analysis was used to describe the characteristics of students at SMP N 1 Lhokseumawe City based on age, gender, HB levels, learning achievement and HBM with anemia. Bivariate analysis was used to test the hypothesis of the relationship between age and anemia, gender with anemia, learning achievement with anemia and HBM with anemia at SMP N 1 Lhokseumawe City using the Chi Square test. The test is declared significant if the p value <0.05 with a 95% confidence interval. The software used is IBM SPSS statistics 25.

The data sources for this study include both primary and secondary data. Primary data were directly obtained from hemoglobin tests, achievement tests, questionnaires, and report card grades of eighth-grade students at SMP Negeri 1 Kota Lhokseumawe who were willing to participate as respondents. Secondary data included report card grades obtained from SMP Negeri 1 Kota Lhokseumawe.

The univariate analysis in this study describes the research variables, which include respondent characteristics (age and gender), hemoglobin levels, academic achievement, and HBM with anemia.

Based on the results of the study, data were obtained regarding the characteristics of the respondents, including age, gender and hemoglobin lavel. The data are presented in the following tables.

Table 4. Characteristics of SMP Negeri 1 Lhokseumawe Students

Characteristics	Frequency (n)	Percentage (%)
Age		
13 years	19	23,8
14 years	53	66,3
15 years	8	10,0
Total	**80**	**100,0**
Gender		
Male	31	38,8
Female	49	61,3
Total	**80**	**100,0**
Hemoglobin Levels		
Normal	47	58,8
Low	33	41,3
Total	**80**	**100,0**

Source: Primary Data, 2024

Table 4 shows the characteristics of respondents who are students of SMP Negeri 1 Kota Lhokseumawe. Out of 80 respondents, the majority are 14 years old, with a percentage of 66.3% (53 students), the majority are female, with a percentage of 61.3% (49 students) and the majority have normal Hb levels, with a percentage of 58.8% (47 students).

This study includes data on student performance, covering achievement tests, performance levels, and report card grades. These data are presented in the tables below.

Table 5. Academic Performance of SMP Negeri 1 Lhokseumawe Students

Dependent Variable	Frequency (n)	Percentage (%)
Achievement Test		
Good	20	25.0
Fair	3 1	38.8
Poor	2 9	36.3
Total	**80**	**100.0**
Achievement Level		
Good	37	46.3
Fair	31	38.8
Poor	12	15.0
Total	**80**	**100.0**
Grades Report		
Good	80	100
Fair	0	0
Poor	0	0
Total	**80**	**100.0**

Source: Primary Data, 2024

Table 5 shows the academic achievement of students at SMP Negeri 1 Kota Lhokseumawe. Out of 80 respondents, the majority had satisfactory results in the achievement tests, with a percentage of 38.8% (31 students). For performance levels, the majority achieved a good performance level, with a percentage of 46.3% (37 students). All students (100%) received good grades on their report cards.

Based on the results of the study, data were obtained regarding the Health Belief Model (HBM) and anemia. These data are presented in the tables below.

Table 6. Overview of Health Beliefs and Anemia

Health Belief Model	Anemia	
	N	%
Perceived susceptibility (*perceived susceptibility*)		
High	35	43.7
Low	45	56.3
Total	80	100.0
Perception of seriousness (*perceived severity*)		
High	45	56.3
Low	35	43.7
Total	80	100.0
Perceived barriers (*perceived barriers*)		
High	35	43.7
Low	45	56.3
Total	80	100.0
Perceived benefits (*perceived benefits*)		
High	35	43.7
Low	45	56.3
Total	80	100.0

Source: Primary Data, 2024

Table 6 presents the Health Belief Model (HBM) related to anemia among students of SMP Negeri 1 Kota Lhokseumawe. Out of 80 respondents, the majority have a low perceived susceptibility, with a percentage of 56.3% (45 students). For perceived severity, the majority have a high perceived severity, with a percentage of 56.3% (45 students). The majority have low perceived barriers, with a percentage of 56.3% (45 students), and for perceived benefits, the majority have low perceived benefits, with a percentage of 56.3% (45 students).

This study also conducted bivariate analysis to determine the relationship between the dependent and independent variables. The bivariate analysis will show the relationship between anemia and academic achievement, and how the HBM is related to anemia among students at SMP Negeri 1 Kota Lhokseumawe.

The relationship between anemia and academic achievement among students at SMP Negeri 1 Kota Lhokseumawe can be determined using the Chi-Square test. Table 7 is a cross-tabulation of hemoglobin levels and academic achievement.

Table 7. Cross-Tabulation of Gender, age with Hb levels

Gender	Hemoglobin					
	Normal		Low		Total	
	n	%	n	%	n	%
Male	20	25	11	13.8	31	38.8%
Female	27	33.8	22	27.5	49	61.3%
Total	**47**	**58.8**	**33**	**41.3**	**80**	**100.0**
Age						
13	14	17.5	5	6.3	19	23.8
14	29	36.3	24	30	53	66.3
15	4	5	4	5	8	10
Total	**47**	**58.8**	**33**	**41.3**	**80**	**100.0**

Source: Primary Data, 2024

Table 7 shows the cross-tabulation of gender, age with hb lavel among students of SMP Negeri 1 Kota Lhokseumawe. Out of 80 respondents, the majority of those with low Hb levels are female, with a percentage of 27.5% (22 students) and the majority of those with low Hb levels are 14 years old, with a percentage of 30% (24 students).

This study also conducted bivariate analysis to determine the relationship between the dependent and independent variables. The bivariate analysis will show the relationship between anemia and academic achievement, and how the HBM is related to anemia among students at SMP Negeri 1 Kota Lhokseumawe.

This study also analyzes the relationship between the Health Belief Model and Hb levels, as shown in Table 5 below.

Table 8 shows the relationship between HBM and anemia among students at SMP Negeri 1 Kota Lhokseumawe. Based on Chi-square statistical tests, the perception of susceptibility shows a p-value of 0.000 ($p < 0.05$), indicating that Ho is rejected or there is a relationship between HBM perception of susceptibility and anemia among students at SMP Negeri 1 Kota Lhokseumawe. For the perception of seriousness, the p-value is 0.668 ($p > 0.05$), indicating that Ho is accepted or there is no relationship between HBM perception of seriousness and anemia among students at SMP Negeri 1 Kota Lhokseumawe. For the perception of barriers, the p-value is 0.531 ($p > 0.05$), indicating that Ho is accepted or there is no relationship between HBM perception of barriers and anemia among students at SMP Negeri 1 Kota Lhokseumawe. For the perception of benefits, the p-value is 1.000 ($p > 0.05$), indicating that Ho is accepted or there is no relationship between HBM perception of benefits and anemia among students at SMP Negeri 1 Kota Lhokseumawe.

Table 8. Analysis of the Relationship Between Health Belief Model (HBM) and Anemia

Health Belief Model	Hb level						P Value
	Normal		Low		Total		
	N	%	N	%	N	%	
Perception Susceptibility							
High	12	34.3	23	65.7	35	100	0,000
Low	35	77.8	10	22.2	45	100	
Total	**47**	**58.8**	**33**	**41.3**	**80**	**100**	
Perception Severity							
High	25	55.6	20	62.9	45	100	0.668
Low	20	44.4	13	37.1	35	100	
Total	**45**	**58.8**	**33**	**41.3**	**80**	**100**	
Perception Barriers							
High	22	62.9	13	37.1	35	100	0.531
Low	24	53.3	21	46.7	45	100	
Total	**46**	**57.5**	**34**	**42.5**	**80**	**100**	
Perception Benefits							
High	20	57.1	15	42.9	35	100	1,000
Low	26	57.8	19	42.2	45	100	
Total	**46**	**57.5**	**46**	**42.5**	**80**	**100**	

Source: Processed Data (2024)

Discussion

Respondent Characteristics

Table 4 shows the characteristics of the student respondents by age, with the majority being 14 years old, categorized as early adolescents by WHO.1,2 Table 4 also show the majority respondents were female. This is consistent with data from the Aceh Population Registration Office.14

Hemoglobin Levels

Table 4 show majority of respondents in this study have good hemoglobin levels, which aligns with a study conducted at SMP Bina Islami, where the respondents had normal hemoglobin levels.15

A study states that iron intake can be a significant indicator of anemia since iron is related to hemoglobin levels. Adequate iron storage in the body promotes red

blood cell formation in the bone marrow. If iron intake is insufficient, the reduction in iron stores will occur gradually.16

Student Performance

Table 5 depicts the performance analysis of students of SMP Negeri 1 Kota Lhokseumawe based on three criteria, namely: (1) Achievement Test – In the Nutrition and Health examination of Math, Science, English, and Indonesian, 25% scored above average, 38.8% were average, and 36.3% were below average. With improved parental nutrition and health awareness, the figures may increase.17,18 (2) Performance Level: Any motivational and interest factors have a positive significant effect on the learning's outcome and therefore motivation needs to be provided in order to increase participation.19,20 (3) Grade Reports: As seen in Table 6, all respondents (100%) are classified under the 'good' category which is in tandem with the findings of the research on anemia and academic achievement at SMA Boyolali where the students with stronger knowledge reported higher averages.21

Overview of HBM and Anemia

Table 6 mentions the Health Belief Model (HBM), which describes the way an individual psychologically takes up health actions using four concepts. Perceived susceptibility explains that most respondents do not think they are at risk for anemia, which impacts their caution. Perceived severity indicates that respondents believe that anemia poses a serious threat, therefore, they take some actions for prevention. Perceived barriers show that most respondents do not see any significant barriers to changing behaviors, but higher values suggest that more change resistance exists. Perceived benefits explains the failure of respondents to appreciate the existence of advantages of taking in more iron nutrition; benefits causes actions.

The center of HBM is always at threat perception and behavioral appraisal. Threat perception deals with susceptibility and severity while appraisal of behavior deals with assessing the benefits and the barriers. The higher perceived risk there is, the more proactive the approach to health behavior becomes. At low perceived risk, an unhealthy choice behaviour becomes the order of the day. Moreover, perceived susceptibility has a bearing on whether a person accepts to adopt a behavior- a person who sees vulnerability tries to take steps to prevent it, while a person who does not see any possibility tends to ignore health related risks. But, there is no guarantee that belief in risk will always lead to a risk behavior.22-26

The Relationship Between Gender and Anemia

The healthy lifestyle and nutritional habits of most female participants are shown in Table 7. The majority of them had normal hemoglobin levels as a result of home-cooked meals, avoidance of risk food sources, and orderly eating patterns. Also, none of them were menstruating which, aside from dropping hemoglobin levels, did not impact the result. Clean water and the socioeconomic state also positively contributed to hemoglobin status, concordant with a study in SMP Karawang where structured diet improved anemia problems.

On the other hand, some female respondents were found to have low hemoglobin. Alhazmi (2024) observed that females tend to have excessive anemia because of low iron intake and behavior patterns associated with iron wasting. Further, socioeconomic and environmental factors aid in the pathology of iron deficiency anemia. Also, evidence suggests adolescent girls are at greater risk of IDA because of insufficient iron intake and loss of blood during menstruation. The losing of iron during menstruation, along with dieting, can decrease the energy intake while getting essential nutrients, which makes one more prone to anemia.27-34

The Relationship Between Age and Anemia

Table 7 shows the majority 14-year-old had low hemoglobin levels. This group also demonstrated relatively greater prevalence of anemia, which is in accordance with different studies suggesting that the lifestyle changes that accompany puberty, diet, and socioeconomic status have an impact on the level of hemoglobin within the body. This research is also in line with the study conducted by Pratiwi Retno at SMP Bina Islami, which showed that 75% of the majority of female students were aged 10-14 years.13,14,15

Multivariable analysis identified that low maternal education, low economic status, female gender, pre-puberty development, low consumption of meat, eggs, and dairy products, and lower daily meal frequency were associated with an increased likelihood of anemia.35 Individuals from higher socioeconomic status may have access and consume more iron- and vitamin C-rich foods.35

Analysis of the Relationship Between Anemia and Academic Achievement

According to the analysis, there is a positive relationship between hemoglobin (Hb) levels and academic performance ($p=0.000$). Performance assessments indicate that 38.8% of students were able to achieve sufficient performance while 25.0% performed adequately. Adequate levels of Hb support concentration and endurance, which aligns with Saraswati's research ($p=0.016$) that found Hb helps in oxygen transport which enables cognitive processes and physical stability.

Also, Sartika's study ($p=0.005$) stressed this association as anemia in adolescents can stifle growth, hinder cognition, and affect concentration resulting in underachievement. Iron deficiency also hinders the development of psychomotor skills and intellectual ability which malaises the performance.

Yanti et al. ($p<0.05$) also put forward the claim that health status has an effect on concentration, which is critical in achieving academic success. Low levels of Hb disturb the metabolism, causing various anemic symptoms that

encourage inefficient learning. Analysis of report cards serves to illustrate this phenomenon as 100% of students were classified as 'good'. This clearly shows that academic achievement is a function of health, learning conditions, and the quality of teaching.36–42

Analysis of the Relationship between the Health Belief Model (HBM) and Anemia

Table 8 examines the perception characteristics of anemia. Vulnerability perception is positively correlated with the Health Belief Model (HBM) and seriousness, barriers, and benefits are not correlated. This indicates that most of the HBM components are not well associated with the rate of anemia. The low severity perception of the clients increases their risk of not undertaking the necessary preventive action because of their perception.
Anemia prevention is based on students' knowledge of iron-rich diets, and knowledge is linked to incidence of anemia. Digital media can increase awareness; in Ilham's study at Malikussaleh University, 87.5% of students improved knowledge from digital education and thus contributes to anemia prevention.40–44.

Strength and Limitations

This research is relevant and up to date with current conditions, discussing the relationship between anemia and academic achievement. This study is interesting because it not only looks at the actual comparison between adolescent academic achievement and anemia, but also looks at how adolescents behave to prevent anemia using the HBM method. The research results will determine how adolescents can prevent anemia and how academic achievement is closely related to anemia.
The limitations of this study are: The research design uses a cross-sectional method where the assessment of the research sample is carried out at one time so that the results produced may be biased. HBM analysis shows that the severity, barriers, and benefits factors do not show a significant relationship with anemia. This may be due to the lack of awareness among adolescents regarding the implementation of anemia prevention.

Conclusion

These findings confirm the impact of anemia on academic achievement, highlighting the importance of iron for brain function, concentration, and intelligence. The limited correlation of most HBM constructs with anemia suggests low student awareness, thus educational interventions are needed to improve preventive behavior.

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