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School-Based Health Education to Improve Health Literacy: A Correlational Study on the Increase of Physical Activity and Students' Nutritional Status

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Abstract

Anemia remains a common issue among adolescents, often linked to an imbalance between physical activity and nutritional status. This study examined the impact of school-based health education on anemia prevalence. A total of 38 students aged 12–15 from MTs Dzunnuroin Malang City participated. Using a quasi-experimental one-group pretest–posttest design, the study evaluated changes in hemoglobin levels among female students. Data were collected through a Digital Hemoglobinometer, Body Mass Index assessment, and the Global Physical Activity Questionnaire. The intervention included the "Active and Nutritious" class and a structured physical activity program over four weeks. Findings showed a positive correlation between moderate physical activity and hemoglobin levels (r = 0.321; p = 0.033), while nutritional status was not significantly related to anemia. After the intervention, average hemoglobin levels increased from 11.3 g/dL to 12.4 g/dL, and anemia prevalence decreased from 31.6% to 18.4%.

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The program also improved students' awareness of active and healthy lifestyles. Overall, regular moderate physical activity combined with nutrition education effectively reduces anemia risk and supports adolescent health in schools.

Keywords: Physical activity; Nutritional status; Health education.

INTRODUCTION

Adolescence is a transitional phase marked by biological, psychological, and social changes that strongly influence future health outcomes. This period involves rapid growth, increased nutritional needs, and significant behavioral changes. Imbalances between nutrient intake, physical activity, and physiological demands can lead to various health problems, including anemia—particularly iron deficiency anemia—which remains a global concern (Manila, 2021). The World Health Organization reports that anemia in adolescents contributes to reduced cognitive capacity, physical endurance, and long-term productivity (Sulistyowati et al., 2023). In Indonesia, anemia prevalence among adolescent girls reaches 37.1% (Ministry of Health of Indonesia, 2023), indicating a serious public health challenge (Syaroful Anam et al., 2025).

Etiologically, adolescent anemia is multifactorial and closely related to nutritional status and physical activity levels. Deficiencies in iron, folate, and vitamin B12 are the main causes of impaired hemoglobin synthesis (Babatunde et al., 2024; Balarajan et al., 2011). Low physical activity can also reduce cardiovascular efficiency and iron metabolism, potentially worsening anemia. In contrast, regular moderate physical activity supports hematological adaptation and oxygen transport (Chaudhary et al., 2022). More than 80% of adolescents globally fail to meet the physical activity guidelines set by the WHO, which raises their risk of health problems, including anemia (Guthold et al., 2020). Various interventions have been developed to reduce anemia prevalence among adolescents. Iron supplementation and food fortification are widely used and effective in increasing hemoglobin levels in the short term. School-based iron tablet programs (TTD) have also shown significant reductions in anemia prevalence, especially when combined with nutrition education (Pasco & Roure, 2022). Additionally, health education interventions aimed at improving nutritional literacy and dietary behavior have demonstrated positive effects on iron intake compliance and hematological status (Cadenas-Sanchez et al., 2021).

More recently, school-based interventions have begun integrating structured physical activity as part of promotive and preventive strategies (Balarajan et al., 2011). Experimental studies indicate that regular moderate physical activity improves cardiorespiratory capacity and

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hematological profiles. Combined interventions involving nutrition education and physical activity are considered more effective than single approaches because they address multiple risk factors simultaneously (Beutler & Waalen, 2006). However, most studies still focus on supplementation or rely on correlational designs without comprehensive experimental interventions.

Previous research has also examined the effectiveness of school-based health education in improving adolescents' knowledge and attitudes toward balanced nutrition and active lifestyles (Jimenez & Lang, 2016). Interventions such as counseling, group discussions, and curriculum integration have been shown to enhance students' health literacy (Benseñor et al., 2007). Nevertheless, many programs remain cognitively oriented and lack systematic integration with sustainable structured physical activity. Empirical evidence using quasi-experimental designs in Indonesian madrasah contexts is still limited, highlighting a research gap in integrated school-based intervention models combining nutrition education and physical activity.

This context aligns with preliminary findings at MTs Dzunnuroin Malang City, which revealed a double burden of nutritional problems: 31.6% of students were classified as obese category I and 47.4% as obese category II, while anemia prevalence was also 31.6%. Most female students had low to moderate physical activity levels. This reflects an imbalance between energy intake, energy expenditure, and micronutrient adequacy, potentially increasing anemia risk. These findings emphasize the urgency of comprehensive school-based interventions focusing not only on supplementation but also on behavioral change through education and structured physical activity.

Based on this gap, the present study employs a quasi-experimental one-group pretest–posttest design to test the hypothesis that integrating school-based health education with structured physical activity programs can significantly increase hemoglobin levels and reduce anemia prevalence among adolescent girls. Specifically, this study aims to: (1) analyze the relationship between physical activity, nutritional status, and anemia prevalence; and (2) evaluate the effectiveness of integrated interventions in improving hematological indicators and health behaviors. This research is expected to contribute empirically to the development of contextual, integrated, and evidence-based school intervention models, while supporting the achievement of Sustainable Development Goal 3 on good health and well-being.

METHOD

Modern-day This study employed a quasi-experimental one-group pretest–posttest design to evaluate the effectiveness of a school-based health education intervention on changes in

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physical activity, nutritional status, and anemia prevalence among adolescent girls. The study was conducted at MTs Dzunnuroin Malang City. A total of 38 female students aged 12–15 years were purposively selected based on inclusion criteria: being actively enrolled, willing to participate in the full intervention, and having no history of chronic disease or hematological disorders. All participants completed both pretest and posttest measurements.

Baseline data were collected to assess participants' initial conditions, including hemoglobin levels, nutritional status, and physical activity. Hemoglobin levels were measured using a Digital Hemoglobinometer EasyTouch GCHb (g/dL), following WHO standards (2022), where Hb < 12 g/dL is classified as anemia. Nutritional status was calculated using Body Mass Index (BMI) = weight (kg) / height² (m^2) and categorized based on WHO Growth Reference (Ministry of Health Indonesia, 2023). Physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ) to measure frequency, duration, and intensity in Metabolic Equivalent of Task (MET-minutes/week). Prior to data collection, coordination was conducted with school staff, teachers, and local health personnel to obtain approval, arrange schedules, and identify students' dietary and activity patterns.



Figure 1. Implementation Process of the Health Education Program

The four-week intervention consisted of two main components. First, an educational program called the "Active and Nutritious" class, which included interactive sessions on balanced nutrition, hydration, anemia prevention, and recommendations for at least 60 minutes of daily physical activity. Second, a structured physical activity program involving morning exercise and active games such as aerobics, skipping, and brisk walking, conducted three times per week. Participants also received educational leaflets and were guided to record their daily food intake to reinforce behavioral changes.

According Evaluation was conducted at the end of the intervention by measuring hemoglobin levels, nutritional status, and physical activity categories. Quantitative data were analyzed descriptively using means, standard deviations, and percentages. In addition, relationships between physical activity, nutritional status, and hemoglobin levels were examined using the Spearman Rank correlation test. To assess the effectiveness of the intervention, a paired

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sample t-test or Wilcoxon Signed Rank Test was used to compare hemoglobin levels before and after the intervention, while the McNemar test was applied to analyze changes in anemia prevalence. The level of significance was set at $p < 0.05$.

Intervention success was determined based on an increase in average hemoglobin levels of at least 1 g/dL, an increase in the proportion of students with moderate-to-high physical activity levels to more than 50%, and an improvement in nutrition knowledge scores to above 75% in the posttest. Success was also evaluated contextually through the emergence of routine group exercise before class and increased teacher involvement as school health facilitators.

RESULTS

The results showed that most participants were classified as obese before the intervention. Of the 38 participants, 13 (34.21%) were categorized as Obesity I and 18 (47.37%) as Obesity II, while only 2 (5.26%) were in the normal category and 5 (13.16%) were overweight. No participants were underweight. After a four-week intervention consisting of structured physical activity and dietary monitoring, changes in nutritional status distribution were observed. The proportion of participants in the normal category increased to 5 (13.16%), overweight decreased to 3 (7.89%), Obesity I declined to 12 (31.58%), while Obesity II remained unchanged at 18 (47.37%).

These findings indicate that the intervention had a positive impact on nutritional status, although most improvements occurred in the overweight and Obesity I groups, while those with severe obesity remained relatively stable. This is consistent with previous literature suggesting that changes in nutritional status among individuals with severe obesity require a longer intervention period, whereas initial improvements in body weight and BMI can begin to appear within four weeks through a combination of physical activity and dietary regulation.

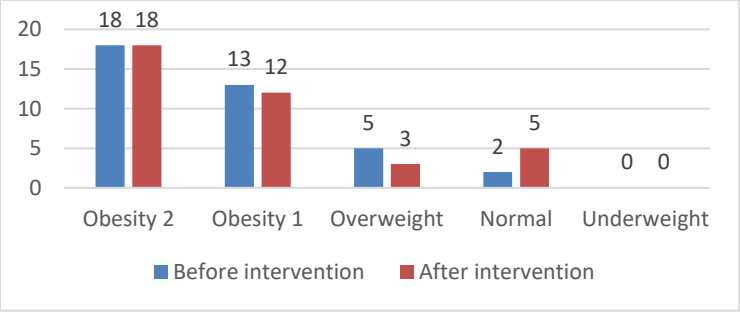


Figure 2. Distribution of Students' Nutritional Status

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The graph (figure 2) shows that before the intervention, most students were in the obesity categories, particularly Obesity II (18 students) and Obesity I (13 students). After the intervention, the number in Obesity II remained unchanged (18 students), while Obesity I slightly decreased to 12 students. More noticeable changes occurred in the overweight category, which decreased from 5 to 3 students, and in the normal category, which increased from 2 to 5 students. No students were classified as underweight either before or after the intervention. These findings indicate that the intervention had a positive impact on improving nutritional status, particularly in the shift from overweight to normal and the reduction in Obesity I. However, no change was observed in the Obesity II group, suggesting that severe obesity may require a longer intervention period to achieve significant improvement.

The results showed that before the intervention, some participants were anemic. Of the 38 participants, 16 (42.11%) were classified as anemic, while 22 (57.89%) had normal hemoglobin levels. After a four-week intervention involving structured physical activity and dietary monitoring, the number of anemic participants decreased to 12 (31.58%), while those with normal hemoglobin levels increased to 26 (68.42%). This indicates that the intervention had a positive, although still limited, effect on participants' hemoglobin status. The short-term reduction in anemia is likely due to improved nutrient intake and increased physical activity, which support iron metabolism and utilization.

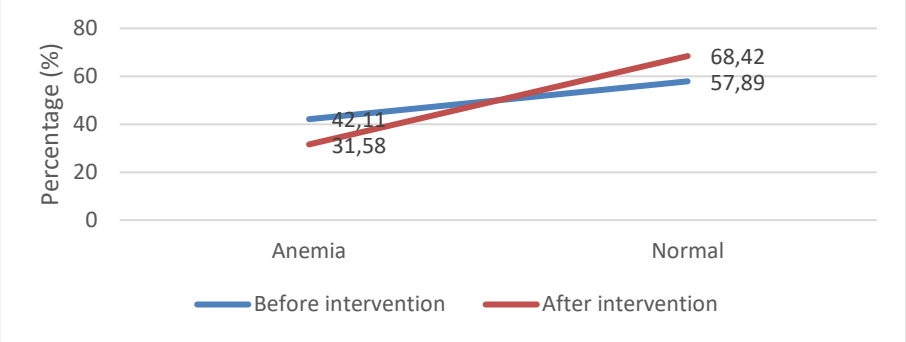


Figure 3. Percentage Distribution of Anemia Status

Meanwhile, adolescents' physical activity levels were generally low. Most students (71.1%) engaged in vigorous physical activity only 1–2 days per week, and the majority (57.9%) performed moderate activity for just 15–30 minutes per session. These findings indicate that a sedentary lifestyle remains dominant, consistent with Guthold et al. (2020), who reported that more than 80% of adolescents worldwide do not meet the WHO's minimum physical activity

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recommendations.

Statistical analysis using the Spearman test showed no significant relationship between BMI and anemia status (r = 0.128; p = 0.444). Although anemia was more frequently found among adolescents with higher BMI (Obesity I = 15.8%; Obesity II = 10.5%), the correlation was not statistically significant. This suggests that obesity does not necessarily have a direct relationship with reduced hemoglobin levels, but it may worsen long-term metabolic profiles when accompanied by an unbalanced diet. This finding is consistent with Lestari et al. (2023), who reported that obesity is not directly associated with anemia but may increase the risk of micronutrient deficiencies due to high-calorie yet low-iron dietary patterns.

Table 1. Frequency of Vigorous Physical Activity

Frequency (days/week)	N	Percentage
0 days	8	21.1 %
1-2 days	27	71.1 %
3-4 days	3	7.9 5 %

Based on the frequency distribution table of physical activity, most adolescents at MTs Dzunnuroin Malang engaged in vigorous physical activity 1–2 days per week (27 students; 71.1%). Meanwhile, 8 students (21.1%) did not engage in any vigorous physical activity, and only 3 students (7.9%) performed it 3–4 days per week. In terms of duration, most respondents carried out vigorous physical activity for 15–30 minutes per session (13 students; 34.2%), followed by less than 15 minutes (10 students; 26.3%), 31–60 minutes (9 students; 23.7%), and more than 60 minutes (6 students; 15.8%).

Table 2. Duration of Vigorous Physical Activity

Duration (minutes/day)	N	Percentage
< 15 minutes	10	26.3 %
15-30 minutes	13	34.2 %
31-60 minutes	9	23.7 %
> 60 minutes	6	15.8 %

Meanwhile, in the category of moderate physical activity, most adolescents engaged in activity 1–2 days per week (26 students; 68.4%). A total of 5 students (13.2%) did not engage in

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any activity, 6 students (15.8%) were active 3–4 days per week, and only 1 student (2.6%) was active 5–7 days per week. In terms of duration, the largest proportion of respondents performed moderate physical activity for 15–30 minutes (22 students; 57.9%), followed by less than 15 minutes (11 students; 28.9%), 31–60 minutes (4 students; 10.5%), and more than 60 minutes (1 student; 2.6%).

Table 3. Frequency of Moderate Physical Activity

Frequency (days/week)	N	Percentage
0 days	5	13.2 %
1-2 days	26	68.4 %
3-4 days	6	15.8 %
5-7 days	1	2.6 %

The results of this study indicate that most adolescents have relatively low to moderate levels of physical activity, both in terms of frequency and duration. This suboptimal pattern of physical activity may affect nutritional status and the risk of anemia, as balanced physical activity plays an important role in iron metabolism and in increasing hemoglobin levels in the blood. Based on grade level, all respondents in Grade 7 were female, totaling 8 students (21.1%). In terms of BMI, most were categorized as Obesity II (5 students; 13.2%), followed by normal (2 students; 5.3%) and overweight (1 student; 2.6%), with no cases of underweight or Obesity I. Regarding anemia status, 2 students (5.3%) were anemic, while 6 students (15.8%) were normal.

Table 4. Duration of Moderate Physical Activity

Duration (minutes/day)	N	Percentage
< 15 minutes	11	28,9 %
15-30 minutes	22	57,9 %
31-60 minutes	4	10,5 %
> 60 minutes	1	2,6 %

In Grade 8, all respondents were also female, totaling 20 students (52.6%). BMI distribution showed that most were in Obesity I (8 students; 21.1%) and Obesity II (7 students; 18.4%), while 3 students (7.9%) were normal and 2 students (5.3%) were overweight. No respondents were underweight. In terms of anemia status, 8 students (21.1%) were anemic and 12 students (31.6%) were normal. Meanwhile, in Grade 9, there were 10 female respondents (26.3%). Based on BMI,

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most were categorized as obese, with 4 students (10.5%) in Obesity I and 6 students (15.8%) in Obesity II. There were no respondents in the normal, overweight, or underweight categories. Regarding anemia status, 2 students (5.3%) were anemic, while 8 students (21.1%) were normal.

Table 5 presents the results of the Spearman correlation analysis examining the relationship between body mass index (BMI), physical activity (both vigorous and moderate), and anemia status. The table includes cross-tabulated data showing the distribution of anemia and non-anemia cases across each variable category, along with correlation coefficients (r) and p-values to determine statistical significance. The variables analyzed consist of BMI categories (underweight, normal, overweight, Obesity I, and Obesity II), frequency and duration of vigorous physical activity, and frequency and duration of moderate physical activity.

From the BMI section, anemia cases are distributed across normal and obesity categories, while no anemia is found in underweight and overweight groups. For vigorous physical activity, most anemia cases occur in participants who engage in activity 1–2 days per week, with fewer cases in higher frequency categories. A similar pattern appears in duration, where anemia is spread across different time ranges without a clear concentration. In moderate physical activity, anemia cases are also mostly found in the 1–2 days category, and in terms of duration, they are more concentrated in the 15–30 minutes group.

Table 5. Correlation Test Results

Variable	Anemia Status		r	p-value
	Anemia	Normal		
BMI				
Underweight	0 (0.0%)	0 (0.0%)	0.128	0.444
Normal	2 (5.3%)	3 (7.9%)		
Overweight	0 (0.0%)	3 (7.9%)		
Obesity I	6 (15.8%)	6 (15.8%)		
Obesity II	4 (10.5%)	14 (36.8%)		
Frequency of Vigorous Physical Activity				
0 days	0 (0.0%)	8 (21.1%)	-0.292	0.075
1–2 days	11 (28.9%)	16 (42.1%)		
3–4 days	1 (2.6%)	2 (5.3%)		
Duration of Vigorous Physical Activity				

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<15 minutes	1 (2.6%)	9 (23.7%)	-0.252	0.127
15–30 minutes	5 (13.2%)	8 (21.1%)		
31–60 minutes	3 (7.9%)	6 (15.8%)		
>60 minutes	3 (7.9%)	3 (7.9%)		
Frequency of Moderate Physical Activity				
0 days	1 (2.6%)	4 (10.5%)	0.072	0.666
1–2 days	10 (26.3%)	16 (42.1%)		
3–4 days	1 (2.6%)	5 (13.2%)		
5–7 days	0 (0.0%)	1 (2.6%)		
Duration of Moderate Physical Activity				
<15 minutes	0 (0.0%)	11 (28.9%)	-0.362	0.025
15–30 minutes	10 (26.3%)	12 (31.6%)		
31–60 minutes	2 (5.3%)	2 (5.3%)		
>60 minutes	0 (0.0%)	1 (2.6%)		

The correlation results show that BMI has a very weak and non-significant relationship with anemia status (r = 0.128; p = 0.444), indicating that BMI does not meaningfully influence anemia in this sample. Vigorous physical activity, both in frequency (r = -0.292; p = 0.075) and duration (r = -0.252; p = 0.127), shows a negative but non-significant relationship, suggesting a tendency that higher activity may reduce anemia risk, although the effect is not statistically confirmed. In contrast, moderate physical activity presents a different pattern. While its frequency is not significantly related to anemia (r = 0.072; p = 0.666), the duration of moderate physical activity shows a significant negative correlation (r = -0.362; p = 0.025). This means that longer durations of moderate physical activity are associated with lower anemia risk.

The findings indicate that among all variables examined, duration of moderate physical activity is the only factor significantly associated with anemia status. This suggests that consistent and sufficiently long moderate physical activity may play an important role in improving hemoglobin levels and reducing anemia risk among adolescents, whereas BMI and vigorous physical activity do not show a significant effect in this study.

DISCUSSION

The findings of this study indicate that anemia among adolescents is a multifactorial

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condition influenced not only by nutritional status but also by behavioral factors, particularly physical activity patterns. The correlation analysis showed that BMI was not significantly associated with anemia status (r = 0.128; p = 0.444). Although descriptively anemia cases were more frequently found among adolescents with obesity, this relationship was not statistically significant. This finding supports previous research suggesting that excess body weight does not necessarily reflect adequate micronutrient intake (Liu et al., 2019). According to World Health Organization, adolescents may experience "hidden hunger," where energy intake is high but micronutrient intake, especially iron, remains insufficient (Berger & Shenkin, 2024). Studies by Balarajan Y et al. (2011) also explain that obesity can coexist with micronutrient deficiencies due to poor diet quality, particularly low iron intake despite high calorie consumption.

In terms of physical activity, vigorous activity did not show a significant relationship with anemia, although the correlation direction was negative (r = -0.292; p = 0.075). This suggests a tendency that increased vigorous activity may reduce anemia risk, but the effect was not statistically confirmed. One possible explanation is that the frequency and duration of vigorous activity among participants were relatively low and inconsistent. According to Efa et al. (2025), more than 80 percent of adolescents globally do not meet recommended levels of physical activity, which limits physiological adaptation such as improved oxygen transport and hematological function. In addition, intense activity without adequate nutritional support may not effectively improve hemoglobin levels. Beard & Tobin (2000) notes that high intensity activity without sufficient iron intake can even worsen iron deficiency.

A more important finding in this study is the significant relationship between the duration of moderate physical activity and anemia (r = -0.362; p = 0.025). This indicates that longer engagement in moderate physical activity is associated with lower anemia risk and better hemoglobin levels. From a physiological perspective, moderate physical activity improves cardiovascular efficiency, enhances oxygen circulation, and stimulates erythropoiesis. Ashcroft et al. (2024) explain that regular moderate exercise supports hematological adaptation and improves oxygen delivery capacity. In addition, moderate activity is more sustainable and easier to perform consistently by adolescents, making it more effective for long term behavior change compared to high intensity activity.

The intervention implemented in this study, which combined health education with structured physical activity, also showed practical effectiveness. The increase in hemoglobin levels and the decrease in anemia prevalence support findings from previous school based intervention studies. Integrated school health programs that include nutrition education and physical activity

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are effective strategies for improving adolescent health outcomes (Sari et al., 2025). Research by Estrela et al. (2025) also shows that educational interventions are more effective when combined with behavioral components such as physical activity and dietary monitoring. The findings of this study emphasize that reducing anemia among adolescents requires not only attention to nutritional status but also consistent behavioral changes, particularly through regular moderate physical activity in school settings. An integrated approach that combines nutrition education and physical activity is essential for achieving sustainable improvements in adolescent health.

CONCLUSION

This study confirms that schools play a strategic role as effective settings for shaping students' health knowledge, attitudes, and behaviors. The integration of nutrition education with structured physical activity demonstrates that learning is not only cognitive but also behavioral and experiential. Students do not merely understand concepts of balanced nutrition and healthy living, but also practice them directly through routine activities, leading to measurable improvements in health outcomes such as hemoglobin levels and reduced anemia prevalence. These findings reinforce the importance of implementing holistic and contextual learning approaches in schools, where health education is integrated into daily routines and supported by active teacher involvement. The success of the intervention also highlights that consistent moderate physical activity, when embedded within the school program, can become a sustainable habit that supports both physical health and learning readiness. Thus, school-based health education should be designed as an integrative program that combines knowledge delivery, behavioral practice, and environmental support. Such an approach not only contributes to improving students' health status but also strengthens the role of schools in developing healthy, active, and productive future generations.

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