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Effect of multiple micronutrient supplements and nutritional education based on the "*Aksi Bergizi*" program on hemoglobin levels of adolescent girls

Efecto de complementos de micronutrientes múltiples y educación nutricional basado en el programa "*Aksi Bergizi*" en los niveles de hemoglobina de niñas adolescentes

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SUMMARY

Background: *Nutritional aspects among adolescents can arise due to incorrect eating habits, leading to an imbalance between nutritional consumption and recommendation, which may result in underweight, overweight, and anemia. Boarding schools are especially susceptible to these issues as they often offer limited food options with behaviors and patterns of skipping eating. This research aims to assess the effect of Multiple Micronutrient Supplements (MMS) and balanced nutritional education on the hemoglobin levels of adolescent girls in boarding schools.* **Method:** *Quantitative research using a case study approach with a one-group pretest-posttest design in 53 teenage girls at boarding school. The intervention consists of nutritional education and MMS, once a week for three months, combined with a persuasive intervention approach to implement food at the boarding school to assess the effect on hemoglobin levels. Data analysis was carried out using SPSS 25, which includes the Shapiro-Wilk and Wilcoxon tests.* **Results:** *The research found a significant improvement in the nutritional and hemoglobin levels of the respondents after the intervention. The average z-score of nutritional status increased from -0.208 ± 1.08 (normal) to -0.047 ± 0.89 (normal), with a p-value of 0.031 (<0.05). Similarly, the average hemoglobin level increased from 11.9 g/dL (anemia) to 12.6 g/dL (not anemic), with a p-value of 0.0001 (<0.05). These results indicate a notable difference between the average before and after the intervention.*

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Conclusion: *The intervention provides multiple micronutrient supplements and nutritional education based on the "Aksi Bergizi" program at the boarding school, significantly improving the hemoglobin levels of adolescent girls in boarding schools.*

Keywords: *Anemia, nutritional education, multiple micronutrient supplements, adolescent girls, boarding school.*

RESUMEN

Antecedentes: *Los problemas nutricionales entre los adolescentes pueden surgir debido a hábitos alimentarios incorrectos, lo que lleva a un desequilibrio entre el consumo y la recomendación nutricional, que puede resultar en bajo peso, sobrepeso y anemia. Los internados son especialmente susceptibles a estos problemas, ya que a menudo ofrecen opciones alimentarias limitadas con comportamientos y patrones de saltarse las comidas. Esta investigación tiene como objetivo evaluar el efecto de los suplementos de micronutrientes múltiples (SMM) y la educación nutricional equilibrada sobre los niveles de hemoglobina de las adolescentes en internados.* **Método:** *La investigación cuantitativa utiliza un enfoque de estudio de caso con un diseño pretest-postest de un solo grupo en 53 adolescentes de un internado. La intervención consiste en educación nutricional y MMS, una vez a la semana durante tres meses, combinado con un enfoque de intervención persuasivo para implementar alimentos en el internado para ver el efecto sobre los niveles de hemoglobina. El análisis de los datos se realizó mediante el programa SPSS 25, que incluye las pruebas de Shapiro-Wilk y Wilcoxon.* **Resultados:** *La investigación encontró una mejora significativa en los niveles nutricionales y de hemoglobina de los encuestados después de la intervención. El puntaje z promedio del estado nutricional aumentó de -0,208 ± 1,08 (normal) a -0,047 ± 0,89 (normal), con un valor p de 0,031 (<0,05). De manera similar, el nivel promedio de hemoglobina aumentó de 11,9 g/dL (anemia) a 12,6 g/dL (no anémico), con un valor de p de 0,0001 (<0,05). Estos resultados indican una diferencia notable entre la media antes y después de la intervención.* **Conclusión:** *La intervención proporciona múltiples suplementos de micronutrientes y educación nutricional basada en el programa "Aksi Bergizi" en el internado, mejorando significativamente los niveles de hemoglobina de las adolescentes en los internados.*

Palabras clave: *Anemia, educación nutricional, suplementos de micronutrientes múltiples, niñas adolescentes, internado.*

INTRODUCTION

Nutrition plays a crucial role in affecting a nation's developed people's health, intelligence, and productivity. A report by the World Health Organization (WHO), the Association of Southeast Asian Nations, and the United Nations Children's Fund indicates that children and adolescents from middle-income countries in Southeast Asia face a "double burden of malnutrition" (DBM). As one of the developing countries, children and adolescents in Indonesia are still struggling to reach global nutrition targets while experiencing DBM, which includes stunting and wasting, micronutrient deficiencies that often manifest as anemia, and being overweight or obese at the same time (1). Adolescence is a critical period in the cycle of life that requires adequate intake of macronutrients and micronutrients to achieve optimal development, growth, and health conditions (2), mainly for adolescent girls who become pregnant and give birth. If adolescent girls face health problems, it can increase the risk of maternal death, premature births, and low birth weight babies (3).

Incorrect nutritional behavior leads to an imbalance between nutritional consumption and nutritional adequacy recommendation, causing underweight, overweight, and anemia in adolescents (4). The Basic Health Research (Riskesdas) (2018) reports indicate a prevalence of adolescent nutritional status based on BMI/U found that the prevalence of adolescent malnutrition 13-18 years was 16.8 % (3.3 % skinny and 13.5 % thin), while overnutrition increased to 29.5 % (20.7 % being overweight and 8.8 % being obese). In addition to over and under-nutrition, adolescent girls are also at risk of anemia due to lack of iron intake. The prevalence of anemia in adolescent girls between 13-18 years old reaches 22.7 %.

Adolescents can develop behaviors and patterns of unhealthy eating habits at school by choosing and consuming high-sugar and fatty food, leading to problems caused by DBM (5). The situation becomes more complex because of the limited related education nutrients in the environment, especially in Indonesian boarding schools, which became schools and places to stay that provide food for the students. At boarding

schools, the food provided plays a significant role in the intake and health status of adolescents (6). Several studies have shown that adolescent girls who attend Indonesian boarding schools have inadequate iron intake from the Indonesian Dietary Recommendation (IDR), which puts them at risk of anemia (6,7). So, behavior fulfillment intake and unhealthy eating habits, as well as lack of knowledge, become the main problems in nutrition among adolescent girls in these boarding schools.

Studies conducted in schools have shown that many students do not yet know their nutritional status and lack knowledge about nutrition-balanced (8). Hence, the availability to access comprehensive information and education-related nutrition, as well as to fulfill adolescent girls' knowledge, so can affect their decision-making skills when it comes to healthy eating habits (9). The government has implemented a program to reduce the prevalence of anemia by providing sufficient iron (iron folic acid/IFA supplement) to increase hemoglobin (Hb) levels. However, efforts to prevent and control anemia have not been optimal due to several obstacles, such as a lack of compliance among adolescent girls (10). Adolescent girls need sufficient knowledge about preventing anemia to improve their iron consumption and effectively control anemia. Since 2016, UNICEF Indonesia has embarked on a new program to support the Government of Indonesia in testing and identifying public health interventions and policy options to support good nutrition during adolescence. The *Aksi Bergizi*, which means Action on a Nutrition Program, is an integrated gender-responsive adolescent nutrition program to support the Government of Indonesia in addressing the triple burden of malnutrition among adolescent girls and boys. The program includes three evidence-based interventions: weekly iron-folic acid supplementation, school-based nutrition education sessions promoting healthy eating and physical activity, and a relevant comprehensive social behavior change communication.

Moreover, an effective alternative for daily supplementation is Multiple Micronutrient Supplements (MMS) tablets. MMS has more complete content than iron folic acid (IFA supplement), which only contains iron and folic acid (11). MMS contains 15 vitamins and minerals, including Vitamins A, C, D, E, B1 (thiamine), B2 (riboflavin), B3 (niacin), B6, B12, folic acid, and Fe (iron) (12), it can be consumed one, two, or three times a week on non-consecutive days (13).

Therefore, this research assessed the effect of MMS and nutritional education on adolescent girls' nutritional status and Hb levels in boarding schools.

METHODS

Research design. This quantitative research uses a case study approach with a one-group pretest-posttest design conducted at one of the Indonesian boarding schools in the Regency. Banggai, Central Sulawesi province, Indonesia. Intervention is based on the educational program *Aksi Bergizi* and supplementation with MMS, which is carried out once a week for three months (September – December 2023), combined with an intervention-persuasive approach in the analysis of food service. Initial measurements of nutritional status and hemoglobin levels were carried out at week 1, and the final data on nutritional status and hemoglobin levels were carried out at the 13th week.

Sample. The respondents were all Junior High School/MTs and Senior High School/ MA adolescent girls, those who were willing to follow the study and fill out informed consent. In total, 54 respondents followed baseline data measurements. Respondents needing help participating in research were excluded from the study (dropout = one respondent). Then, 53 respondents with anemia or not investigated their nutrition status and hemoglobin level further to investigate the impact before and after the intervention.

Data collection. Balanced nutrition education for adolescents is provided through 12 weekly sessions, each lasting 30-45 minutes, using leaflets and posters containing material from educational modules, such as *Aksi Bergizi* programs for adolescents. The aim is to increase knowledge about nutrition among adolescents, and educational intervention is done along with MMS supplementation. The persuasive approaches encourage the consumption of energy-

dense foods and provide sample food menus that are balanced for practice.

Data measurement. This research used digital scales to measure body weight and Microtoice to measure height, which is then used to calculate the z-score (BMI/U) using WHO Anthro Plus. The z-score categories are Thinnesss (< -3SD to < -2 SD), Normal (-2SD to 1SD) and Overweight (1SD to 2SD). Blood hemoglobin levels were measured using HemoCue Hb 201, with categories of ≥ 12 g/dL indicating no anemia and <12 g/dL indicating anemia.

Statistical analysis. Statistical analysis was done using SPSS for Windows ver.25. The significance level was $p<0.05$. To analyze the nutritional status and hemoglobin levels using the Shapiro-Wilk test for normality, the paired t-test was used when the data was obtained normally distributed, and the Wilcoxon test was used if the data was distributed abnormally.

Ethics. This research was approved by the Hasanuddin University Health Research Ethics Committee with ethical approval recommendation number 5302 /UN4.14.1/ TP.01.02/2023. Respondents' participation in this research is voluntary, and those who agreed to participate had filled out informed consent.

RESULTS

This study involved 53 respondents categorized into junior high school/MTs/SMP and senior high school/MA/SMA levels from classes 1, 2, and 3. Most respondents fell into the early adolescence category (aged 12-15 years) (60.4 %). The majority of respondents came from families with 5-8 members (71.7 %), and in terms of last education, most fathers graduated from junior high school (32.1 %), and most mothers completed elementary school (33.9 %). Over half of the respondents had fathers who worked in agriculture (58.5 %), and 35.8 % of the mothers were also employed in agriculture. The highest percentage of the family's income was less than the minimum wage (<Rp 2.566.281) (64.2 %) (Table 1).

Figure 1 shows that most adolescent girls (88.7 %) had experienced menstruation before and after the intervention. Before the intervention, only 7.5 % of girls consumed IFA, but after the intervention, all of them did (100 %). Compliance with weekly MMS consumption was 98.1 %.

Figure 2 shows the variables of nutritional status and anemia status of respondents. It can be seen that 24.1 % of respondents had nutritional status problems (thinness and overweight) before intervention; this number was reduced to around 5.7 %. Furthermore, before intervention, 17 respondents (31.0 %) had anemia status. After the intervention, the number of respondents with anemia status was reduced to only 5 (9.0 %).

Table 2 shows that the average body weight before the intervention was 44.23 kg, increasing to 45.25 kg, with a standard deviation of 7.49 to 6.94 after the intervention. The difference in average body weight is 1.02, with a standard deviation of 0.55. Nutritional status in adolescents is measured using the z-score of BMI/U. This nutritional status is categorized as thinness if the z-score value is between < -3 SD to < -2 SD, normal if the z-score value is between -2 SD and 1 SD, and overweight if the z-score value is between 1 SD and 2 SD. The average z-score before the intervention was -0.208 to -0.047 after the intervention; both values were included in the normal nutrition category. The average difference in the z-score is -0.161, with a standard deviation of 0.192. After the Wilcoxon test to assess whether there was a significant difference in body weight and nutritional status z-score values before the intervention and after the intervention, a p-value of 0.0001 was obtained for body weight, and 0.031 for the z-score nutritional status indicating that there was a significant difference, both between body weight and the average z-score of nutritional status before and after the intervention is given.

Hemoglobin levels are indicators used to assess anemia status. If hemoglobin levels <12 g/dL are categorized as anemia, those ≥12 g/dL are categorized as not anemia. Table 3 presents the average hemoglobin level before the intervention, which was 11.9 g/dL and increased to 12.6 g/dL after the intervention. A Wilcoxon test was carried out to evaluate if there were significant

Table 1. Characteristics of Respondents

Characteristics		n = 53	%
Class			
Senior High	XII	6	11.3
School/MA	XI	7	13.2
	X	7	13.2
Junior High	IX	7	13.2
School/MTs/SMP	VIII	14	26.4
	VII	12	22.6
Age			
12-15 Years			
16-18 Years		21	39.6
		32	60.4
Family Member			
2-4 People		15	28.3
5-8 People		38	71.7
Parents Education			
Father's	Elementary school	15	28.3
Education	Junior High School	17	32.1
	Senior High School	15	28.3
	Diplomat/DIII	1	1.9
	Bachelor's Degree (DIV/S1 /S2)	5	9.4
Mother's	Elementary school	18	33.9
Education	Junior High School	12	22.6
	Senior High School	17	32.1
	Diplomat/DIII	0	0
	Bachelor's Degree (DIV/S1 /S2)	6	11.3
Parents' Occupation			
Father's occupation			
Farmers/Fishermen		31	58.5
Civil servants/ Military/Police		4	7.5
Private employees		7	13.2
Self-employed		9	17.0
Doesn't work		1	1.9
Other		1	1.9
Mother's Occupation			
Farmers/Fishermen		19	35.8
Civil servants/ Military/Police		6	11.3
Private employees		2	3.8
Self-employed		6	11.3
Doesn't work/IRT		17	32.1
Other		3	5.7
Family Income per month			
<Min. Wage		34	64.2
≥Min. Wage		19	35.8

Source: Primary Data, 2023. IRT: Income Reporting Threshold

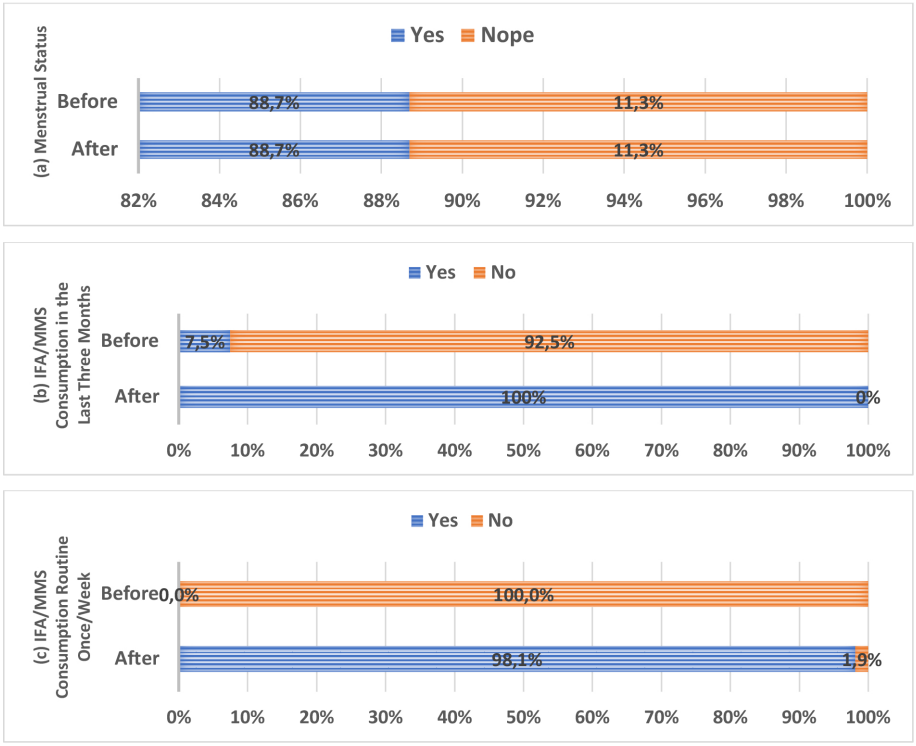

Figure 1. Distribution of Respondents Based on Menstrual Status and IFA/MMS Consumption Behavior in the Last Three Months. Sumber: Data Primer, 2023

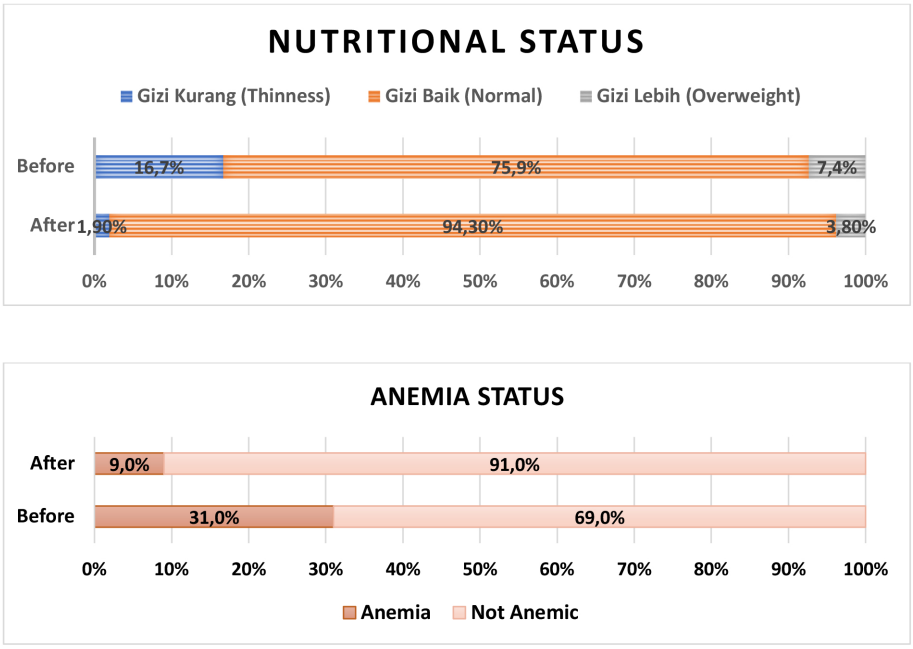

Figure 2. Distribution of Changes in Nutritional Status and Anemia in Adolescent Girls Before and After Intervention.

Table 2. Analysis of differences in body weight and nutritional status before and after intervention in adolescent girls

Variable	Mean Z-Score ± SD Before Intervention	Mean Z-Score ± SD After Intervention	Difference Mean±SD	P Value
Body Weight (kg)	44.23 ± 7.49	45.25 ± 6.94	1.02 ± 0.55	0.0001
Nutritional status (Z-score IMT/U)	-0.208 ± 1.08	-0.047 ± 0.89	0.161 ± 0.19	0.031

Source: Primary Data, 2023, [a]Wilcoxon test

Table 3. Differences in hemoglobin levels before and after intervention in adolescent girls

Variable	Before Intervention Mean±SD	After Intervention Mean±SD	Difference Mean±SD	P Value
Hemoglobin Levels (g/dL)	11.9 ± 1.16	12.6 ± 0.93	0.7 ± 0.23	0.0001

Source: Primary Data, 2023, a Wilcoxon test

differences in values of hemoglobin levels before and after the intervention; the obtained p-value = 0.0001 on hemoglobin levels before and after intervention shows correlations and significant differences between hemoglobin levels before and after intervention. Therefore, it can be concluded that the intervention provided to the adolescent girl significantly influenced her hemoglobin levels.

DISCUSSION

Nutritional Status is a comprehensive overview of food intake and physical condition, primarily focusing on various features such as body composition, pathological and biochemical indices, and performance measures. Nutritional status describes the body's condition as a consequence of food consumed, absorption of nutritional intake, and energy use as an indicator. One method that can measure nutritional status is anthropometric measurements, used to assess the human body's size, proportions, and composition; they include height, weight, head circumference, and limb length. The nutritional status can then influence various aspects of life, especially during adolescence; the body needs adequate and balanced nutrition to support optimal growth and development, health status, and the cognitive development status of children (14). Adequate nutritional needs must be addressed to maintain good nutritional status; various factors, including intake and eating behavior, influence this.

Adolescents' nutritional intake, especially those attending boarding Indonesian schools, must be considered. Busy activities mean that students only rely on food at times and portions provided by food providers in the dormitory or school. It has been shown that the nutritional intake of students who live in dormitories is lower than those who do not (15). Our present data align with this concept since they show that the average food intake of respondents is under adequate nutrition. Providing education on nutrition balance and MMS to respondents and implementing food interventions increases the average intake. Hardinsyah et al. (2016) state that nutrition education is important because it can improve the knowledge and skills required to develop practices and behaviors for healthy eating according to the principle of nutritional balance (16).

The direct and thorough food recall observation shows that respondents eat snacks more than they consume main meals. Skip-eating behavior can lead to inadequate food intake, which can cause micronutrient and macronutrient deficiencies (17). This condition can describe and even result in undernutrition or poor malnutrition in adolescent girls.

We show a significant improvement in hemoglobin levels after the intervention, with a decrease in anemia by 22 %, as well as an average increase in hemoglobin levels of 0.7 g/dL. This is in line with a previous study which examines whether long-term once- or twice-weekly supplementation of MMN can improve hemoglobin (Hb) and micronutrient status more than twice-weekly IFA supplementation in anemic adolescent girls in Bangladesh. They demonstrated that although all three treatments effectively reduced iron deficiency, once-weekly MMN produced significantly lower serum ferritin concentrations than the other treatments at both 26 and 52 wk. Both once- and twice-weekly MMN significantly improved riboflavin, vitamin A, and vitamin C status compared with IFA. Overall, once-weekly MMN was less productive than twice-weekly MMN in improving iron, riboflavin, RBC folic acid, and vitamin A levels. Micronutrient supplementation beyond 26 weeks was likely important in sustaining improved micronutrient status (18). Adding other micronutrients to iron and folic acid supplements, given twice weekly, can marginally but significantly improve Hb response in adolescent girls with nutritional anemia. This has considerable implications for reducing anemia and micronutrient deficiencies among anemic adolescent girls in low-income countries. In addition to reducing the prevalence of anemia, it can continue to improve and maintain iron stores and improve micronutrient status in the body to prevent anemia when it reaches maturity.

Study Limitations and Recommendations. This research has limitations, including the study being one group pretest-posttest. Only conducted in one school, due to considerations regarding the implementation of the test, it is difficult to obtain a control group of respondents that did not undergo the intervention that is equally considered with the intervention group in the same area cause that both groups of respondents have considered homogeneous. To adequately demonstrate the effects of an intervention accurately, intergroup comparisons between the intervention and control groups are necessary. Besides, it can be added that other groups also saw the single effect of MMS intervention only, education only, or food delivery intervention only. Additionally, the duration of research can also be extended to show more real effects of interventions such as iron storage/ferritin levels in the blood.

CONCLUSION

The intervention, which provides multiple micronutrient supplements and nutritional education based on the "*Aksi Bergizi*" program at the boarding school, significantly improves the hemoglobin levels of adolescent girls in Indonesian boarding schools.

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