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Effect of School-Integrated Interventions on Improvement of Nutrition-Health Knowledge and Nutritional Status among Adolescent Girls: A Quasi-Experimental Study

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Abstract

Adolescent girls in Indonesia face triple burdens of malnutrition, which will harm the next generation. This study aimed to assess the efficacy of school-integrated interventions on nutrition-health knowledge and nutritional status among adolescent girls. A quasi-experimental study design involved 342 female adolescents in the entire study series from 2021-2023. The intervention school was provided nutrition-health education by trained teachers plus nutrition-health services at the Adolescent Girls' Integrated Health Post (Posyandu) (n=262); the comparison only received nutrition-health education from trained teachers at their school (n=80). Nutrition-health knowledge (standard questionnaire), nutrients and dietary intake (food recall form 2x24 hours and food frequency questionnaire), and nutritional status were collected through anthropometric and biochemical assessments in both groups. There was an increase in the mean value of all aspects of nutrition-health knowledge. This increase was higher in the intervention group. The malnutrition biomarkers decreased significantly in the intervention school comprised of anemia was 3.4%, Chronic Energy Deficiency (CED) was 24.1%, severe stunted at 0.8%, and wasting at 1.6%, but overweight increased by 1.2%. In the comparison school, only CED decreased significantly by 26.2%, while anemia, severe stunting, wasting, and overweight increased significantly. In conclusion, school-integrated interventions were more effective than nutritional education alone in improving nutrition-health knowledge and nutritional status among adolescent girls.

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Introduction

Currently, the world faces a triple burden of malnutrition characterized by under-nutrition (stunted growth), overweight, and micronutrient deficiencies simultaneously in an individual.[1,2] Indonesia is no exception, girl adolescents are among the most affected by the triple burdens of malnutrition. Approximately 1 in 4 adolescent girls experience anemia, the prevalence increasing by 84.6% among pregnant adolescents, 1 in 4 middle and late female adolescents suffer stunted, while almost 1 in 7 adolescents are overweight or obese.[1,3,4]

One crucial aspect related to the triple burden of malnutrition in female adolescents is their knowledge of nutrition.[5,6] Research has shown that nutritional knowledge can significantly influence adolescent eating behavior,[7,8], and eating behavior is a modifiable factor that directly affects nutrient intake and nutritional status.[9,10]

Unfortunately, multiple studies conducted in various countries have demonstrated that adolescent girls often possess inadequate knowledge about nutrition and health.[11–14] Addressing this knowledge gap is crucial for promoting healthier eating behaviors and improving the nutritional status of adolescent girls. Studies on the effect of health-nutrition education interventions on knowledge, eating behavior/nutrient intake, and nutritional status of female adolescents have been conducted in various countries, such as Jordan,[15] Indonesia,[16] Ghana,[17] and Croatia.[18] The results of a systematic review show that health and nutrition education interventions to increase knowledge and practice on malnutrition show varying success.[19] Nevertheless, it is essential to note that interventions in nutrition and health education for adolescents can positively affect their current nutritional and health status, also the future growth and development of their offspring, thereby helping to break the intergenerational cycles of malnutrition.

In Indonesia, existing studies on nutrition education interventions have not yet integrated nutrition programs such as nutritional supplementation and health-nutrition education.[3,5,16,20] Additionally, the Youth Posyandu Program, which targets teenagers in the community only, has not been implemented on a school-wide basis, even though the number of teenagers attending school has significantly.[21] So, there is a need for integrated nutrition programs that combine nutritional supplementation and health-nutrition education, particularly within the school setting. Furthermore, expanding the Youth Posyandu Program to schools could effectively reach a larger population of teenagers and contribute to improving their nutrition and health status.

West Sulawesi Province is the second highest prevalence of stunting under five (33.8%) in Indonesia.[22] Moreover, 38.49% of adolescent girls (15-19 years) suffer from chronic energy deficiency. stunting for ages 13-15 (39.3%), and 42.6% for ages 16-17 years.[4] The study focused on Majene Regency as the area with the second highest prevalence of stunting (35.7%) in West Sulawesi Province.[22] which previously had the highest prevalence in West Sulawesi.[4]

According to available knowledge, no studies have been conducted on school-based Posyandu for adolescent girls integrated with nutrition-health education by trained teachers in every school, specifically in the West Sulawesi province of Indonesia. Additionally, there has been nothing involvement of students as health cadres in monitoring adolescent girls' growth and nutritional status sustainably through the school Posyandu program. This lack of intervention represents a missed opportunity to invest in efforts to prevent stunting across generations. Therefore, this study aimed to assess the efficacy of school-integrated interventions on nutrition-health knowledge and nutritional status among adolescent girls.

Material and Method

Design

This study used a quasi-experiment method with a pre-post control group design.

Population and Sample Study

Two group schools were randomly selected, namely, the intervention group consisting of two schools under the Ministry of Education, Culture, and Technology Research (SMPN 1 and SMAN 1 Majene). The comparison group also consisted of the two schools under the Ministry of Religion comprised of Madrasah Tsanawiah (MTS) and Madrasah Aliyah (MA). All seventh-grade girls in junior high school or Madrasah and tenth-grade for SMA or MA students were involved in this study, which consisted of 271

girl students in the intervention group and 89 girl students in the comparison group. Nine students from each of the intervention and comparison schools dropped out of this study.

Ethical Consideration

Ethical approval was obtained from the ethics committee for health research, Faculty of Medicine, Hasanuddin University (No: 194/UN 4.6.4.5.31/ PP36/2020). The local government and school principals in the research locations have also approved the implementation of this research. This study complies with the principle of Helsinki Declaration. Before data collection, the research team conducted socialization with the teachers and students to explain the procedures for this research activity, the objectives, benefits, side effects of taking peripheral blood, data confidentiality, and the right to refuse and withdraw from this research.

After the explanation, if they agreed to participate in this study, they signed an informed consent to be involved in this study.

Intervention Method

Adolescent girls in the intervention schools were given educational interventions plus establishing and implementing a female teenager-integrated health post (Posyandu) in school. Teachers trained (14 people) by the research team provided four weeks of educational intervention. They taught 16 topics (Table 1) as outlined in the booklet. The booklet was pre-validated before the implementation of the intervention.

Table 1: Health-Nutrition Education Subject for School-Based Adolescent Girls

No	Booklet Title	Topic
1	Malnutrition and nutrition in the first 1000 days of life	1. Malnutrition
		2. Nutrition in pregnant women
		3. Nutrition in Breastfeeding Mothers
		4. Nutrition for children under two years
2	Healthy Nutritional Behavior for Adolescent girls	1. Food Groups and Additives
		2. Important Things to Grow Healthy
		3. Risk for Nutritional Problems in Adolescent Girls
		4. Vulnerability and Risk in Adolescent girls
3	Reproductive Health for Adolescent girls	1. Structure of the Reproductive Organs
		2. Menstruation & Related Problems
		3. Pregnancy and it's complication
		4. Sexually Transmitted Infections and disease
		5. Sexual Violence & Abortion
		6. Influence of social media on free sex behaviour and ways to overthrow it
		7. Reproductive Health Rights
4	Physical Activity	Types of physical activity and its benefits

The delivery of the material was carried out around 40-90 minutes per material, depending on the number of the material taught by the teacher using PowerPoint, Video, and LCD (liquid crystal display). Nutrition-health education begins with a pre-test, then ends with a post-test after the delivery of the material. After one-month post-education, female students were re-tested using the same questionnaire before the intervention to assess students' knowledge retention after the intervention.

The intervention schools, in addition to nutrition education, nutrition-health services were also provided to adolescent girls, including[1] monitoring of growth and nutritional status by measuring anthropometry (weight, height, and upper arm circumference) carried out by eight female students trained as School Posyandu cadres, guided by the research team;[2] Multi-micronutrient supplementation contains (Vitamin A 800 mcg, RE, Vitamin C 70 mg, Vitamin D 5 mcg (200 IU), Vitamin E 10 mcg α-TE

(tocopherol equivalents), Vitamin B1 (Thiamine) 1.4 mg, Vitamin B2 (Riboflavin) 1.4 mg, Vitamin B3 (Niacinamide) 18 mg, Vitamin B6 (Pyridoxine) 1.9 mg, Folic Acid 400 mcg, Vitamin B12 2.6 mcg, Iron 30 mg, Iodine 150 mcg, Zinc 15 mg, Selenium 65 mcg, Copper 2 mg), was given and distributed directly by primary health care officers (2 people) and community Posyandu cadres (4 people) on the day of Posyandu activities as much as four tablets to be consumed one tablet per week for four weeks by girl students;[3] nutrition-health counseling to the adolescent girl by trained Primary Health Care officers and Posyandu cadres using poster media. Health nutrition services were carried out for four consecutive months in 2022 at the Adolescent Girl Posyandu, previously formed by a research team at schools under the coordination of the school health unit.

The adolescent girls in the comparison schools only received nutrition-health education from eight teachers who had also been trained by the researcher, using the same method as the intervention schools.

Each type of intervention implementation was supervised directly by the researchers.

Data Collection

Data on the characteristics of adolescent girls and their parents (demographic), nutrition-health knowledge (collected using a standardized questionnaire), nutritional status based on anthropometry, biochemistry, and nutritional intake were collected in 2021 (baseline data) and 2023 (end-line data). The implementation of educational interventions and health and nutrition services in the Posyandu for Adolescent Girls in 2022 was preceded by CIE (communication, information, education) media trials and training for teachers and community cadres Posyandu who would be involved in the intervention program.

The nutritional status of girl adolescents is assessed based on the intake of nutrients, anthropometric and biochemical. All anthropometric tools and Hemocue Hb 301 machines (hemoglobin analyzer) were calibrated before being used in the measurements. Assessment of nutrient intake (energy, protein, calcium, vitamins A, C, D, E, Folic acid, Iron, and Zinc) using a 2X24 hour recall form and the frequency of intake of each food was obtained from the dietary survey using a food frequency questionnaire (FFQ). Anthropometric measurements consisted of measuring body weight using a digital scale (d=0.1 kg), height measured using a microtoice (d=0.1 cm), and mid-upper arm circumference (MUAC) measured using a measuring tape (d=0.1 cm).

The anthropometric measurements of body weight and height processed by using the WHO Anthroplus Version 1.0.4 software to obtain a Z-score for Height-for-Age index (HAZ-score) (stunted: HAZ-Score between minus 3 SD to below minus 2 SD, severe stunted: HAZ-score below minus 3 SD), and z-score Body Mass Index according to Age (BAZ-score) (wasted: BAZ-Score= between minus 3 SD to below minus 2 SD, severely wasting : BAZ-Score = below minus 3 SD, overweight: BAZ-Score = between above +2 SD to +3 SD, obesity: BAZ-Score = above +3 SD)23. Assessment of chronic energy deficiency (CED) based on measuring the mid-upper arm circumference (CED = If MUAC is below 23.5 cm)4. Biochemical assessment through blood examination taken from the subject's middle finger as much as ± 1 drop (< 1 ml) to measure hemoglobin (Hb) levels) using the Hemocue Hb 301 analyzer (According to the WHO, anemia if Hb < 12 g/dl).[24] Nutrient intake was analyzed using the 2007 Nutrisurvey Application.

Data Analysis

Data were analyzed using software the Statistical Package for Social Sciences/SPSS 24 (IBM SPSS Inc. Chicago IL.USA). The results are shown in means, standard deviations (SD), frequency and percentage. The assessment of the improvement in the nutritional status of adolescent girls is based on the increase in the value of each index of nutritional status, namely the HAZ-scores, BAZ-score, mid-upper arm circumference, and hemoglobin level. These values are interpreted based on the criteria of each parameter of the nutritional status.[4,23,24]

The assessment of improvement of knowledge of health-nutrition and nutritional status of female adolescents before and after the intervention using a Paired T-test (for continuous data).

Meanwhile, to assess the differences in knowledge and nutritional status between the two groups used

by the Independent T-test (for continuous data). The assessment of the differences intra and inter-group about the sample characteristics (demographic profile) and nutritional status (for categorical data) using the Chi-Square and McNemar's tests. P-values < 0.05 was considered significant.

Table 2: Demographic Profile of Subjects

Variable	Intervention (n=262)	Comparison (n=80)	P- value
Age (years); mean±SD#	16.13±1.6	16.35±1.5	0.275
• 13-15	106 (40.5)	27 (33.8)	
• ≥16-18	156 (59.5)	53 (66.3)	
Mother's education, n (%)##			
• Low	114 (43.5)	44 (55.0)	0.071
• High	148 (56.5)	36 (45.0)	
Father's education, n (%)##			
• Low	106 (40.5)	45 (56.3)	0.013
• High	156 (59.5)	35 (43.8)	
Mother's occupation, n (%)			
• Trader	10 (3.8)	2 (2.5)	
• Civil Servant	49 (18.7)	6 (7.5)	
• Private Employees	4 (1.5)	0	
• Housewife	179 (68.3)	67 (82.5)	
• Enterpreneur	15 (5.7)	3 (3.8)	
• Others	5 (1.9)	2 (2.6)	
Mother's occupation category, n (%)##			
• Formal	58 (22.1)	7 (8.8)	0.008
• Non-Formal	204 (77.9)	73 (91.2)	
Father's occupation, n (%)			
• Farmer	18 (6.9)	26 (32.5)	
• Labour	2 (0.8)	5 (6.3)	
• Trader	7 (2.7)	1 (1.3)	
• Civil Servant	62 (23.7)	6 (7.5)	
• Private Employees	7 (2.7)	2 (2.5)	
• Entrepreneur	61 (23.3)	15 (18.8)	
• Fisherman	66 (25.2)	10 (12.5)	
• Carpenter	6 (2.3)	3 (3.8)	
• Others	33 (12.6)	10 (12.5)	
Father's occupation category, n (%)##			
• Formal	75 (28.6)	13 (16.3)	0.027
• Non-Formal	187 (71.4)	67 (83,6	

Note: #Analyzed by T independent Test ## Analyzed by Chi-square Test

Result

Based on the socio-demographic characteristics of the study participants and their families, results showed that the age of the adolescent girls involved in this study did not differ significantly between the two study groups. However, the parental background (occupation and education) between the intervention and comparison groups was significantly different, except for mother's education (Table 2).

Table 3: Knowledge of Stunting and Nutrition for Adolescent girls, and the First 1000 Days of Life Before and After Intervention in the Two Study Group

Variable	Intervention (n=262)		Comparison (n=80)		Mean Difference	p-value#
	Min-Max	Mean±SD	Min-Max	Mean±SD		
Before Intervention						
Knowledge of stunting	4-36	19.42±7.8	9-31	22.36±6.1	2.94±0.8	0.000
Knowledge of Adolescent girls' Nutrition	1-11	6.20±2.9	1-11	7.00±2.5	0.79±0.3	0.019
Knowledge of Nutrition for Pregnant & Breastfeeding Mothers	1-23	12.07±5.9	5-22	13.67±5.2	1.61±0.7	0.021
Knowledge of Infant and Toddler Nutrition	0-9	4.85±2.1	1-8	5.39±1.7	0.54±0.2	0.017
Total score for All Items	12-74	42.54±16.8	22-70	48.43±12.9	5.88±1.8	0.001
After Intervention						
Knowledge of stunting	6 - 37	25.97±6.5	13 - 37	25.03±5.5	0.94±0.8	0.240
Knowledge of Adolescent girl's Nutrition	1 - 11	7.74±2.6	3 - 11	7.35±2.0	0.39±0.3	0.159
Knowledge of Nutrition for Pregnant & Breastfeeding Mothers	2 - 26	16.23±5.5	7 - 25	17.29±3.8	1.06±0.5	0.053
Knowledge of Infant and Toddler Nutrition	1 - 9	6.14±1.9	2 - 9	6.01±1.7	0.13±0.2	0.603
Total score for All Items	16 - 79	56.1±14.4	28 - 76	55.7±10.5	0.39±1.5	0.797

Note : # Analyzed by T independent Test

Adolescent girls' knowledge regarding stunting and nutrition in the first 1000 days of life significantly differed between the two study groups before the intervention was given, in which the mean value of all aspects of knowledge was higher in the comparison group than the intervention group. However, after being given education interventions and nutrition-health services at the Adolescent Girls Integrated Post (Posyandu), no significant difference in knowledge was observed with the comparison group (Table 3).

Furthermore, there were positive changes in all aspects of knowledge of adolescent girls after the intervention in each group, marked by a significant increase in the mean value of each aspect of knowledge after receiving the intervention, except for knowledge of adolescent girls' nutrition in the comparison group. The mean value of knowledge increased higher in the intervention group compared to the comparison group (Table 4).

The results of the present study also showed that before the intervention, almost all nutrients were consumed more by female adolescents at the intervention school. However, only three micronutrients intake (vitamin D, iron, and zinc) differed significantly between the two groups. Nevertheless, after the intervention, the intake of the three micronutrients was no longer significantly different between the two study groups. Only calcium intake was significantly different, which more female adolescents consumed at the intervention school than at the comparison school. Thus, the total intake of various types of nutrients was higher in the intervention group (Table 5).

Table 4: Changes in Nutrition Knowledge for adolescent girls and the first 1000 days of life in Both Study Groups

Variable	Baseline		Endline		Mean Difference	p-value#
	Min-Max	Mean±SD	Min-Max	Mean±SD		
Intervention Group (n=262)						
Knowledge of stunting	4 - 36	19.42±7.8	6 - 37	25.97±6.5	6.55±7.8	0.000
Knowledge of Adolescent girls' Nutrition	1 - 11	6.20±2.9	1 - 11	7.74±2.6	1.54±2.9	0.000
Knowledge of Nutrition for Pregnant & Breastfeeding Mothers	1 - 23	12.07±5.9	2 - 26	16.23±5.5	4.16±6.5	0.000
Knowledge of Infant and Toddler Nutrition	0 - 9	4.85±2.1	1 - 9	6.14±1.9	1.29±2.2	0.000
Total score for All Items	12 - 74	42.54±16.8	15 - 79	56.07±14.4	13.54±15.9	0.000
Comparison Group (n=80)						
Knowledge of stunting	9 - 31	22.36±6.1	13 - 37	25.03±5.5	2.66±6.5	0.000
Knowledge of Adolescent girl's Nutrition	1 - 11	7.00±2.5	3 - 11	7.35±2.0	0.35±2.4	0.190
Knowledge of Nutrition for Pregnant & Breastfeeding Mothers	5 - 22	13.67±5.2	7 - 25	17.29±3.8	3.61±5.8	0.000
Knowledge of Infant and Toddler Nutrition	1 - 8	5.39±1.7	2 - 9	6.01±1.7	0.63±2.0	0.007
Total score for All Items	22 - 70	48.43±12.9	28 - 76	55.7±10.5	7.25±12.3	0.000

Note : # Analyzed by T independent Test

Table 5: Nutrient Intake of Adolescent Girls Before and After Intervention in Both Study Groups

Variable	Intervention (n=262)		Comparison (n=80)		Mean Difference	p-value#
	Min-Max	Mean±SD	Min-Max	Mean±SD		
Before Intervention						
Energy (kcal)	314.4 - 3636.9	1267.8±585.9	325.5 - 2669.6	1213.3±432.3	54.5±60.4	0.368
Protein (g)	10.8 - 215.1	51.1±25.9	10.7 - 343.2	58.6±67.1	7.5±7.6	0.333
Calcium (mg)	17.1 - 2571.1	373.9±441.2	20.2 - 1756.4	315.7±321.4	58.2±45.1	0.199
Vitamin D (mcg)	0.0 - 24.4	6.5±5.3	0.3 – 15.1	3.67±3.69	2.8±0.5	0.000
Vitamin A (mcg)	15.7 - 27190.9	449.9±1693.4	16.6 - 1348.2	250.6±236.9	199.3±190.1	0.295
Folic Acid (mcg)	9.6 - 1426.2	88.9±98.7	20.6 - 225.8	81.2±44.4	7.7±20.8	0.712
Vitamin C (mg)	0.0 - 937.6	27.1±76.7	0.3 - 166.3	17.1±33.5	9.9±6.0	0.261
Vitamin E (mcg)	0.0 - 16.5	4.0±2.7	0.8 – 11.4	3.9±2.2	0.1±0.3	0.647
Iron (mg)	0.7 - 34.9	6.4±5.6	0.8 – 17.8	4.9±3.4	1.6±0.5	0.003
Zinc (mg)	0.7 - 17.2	4.9±2.9	0.6 - 11.8	4.0±2.1	0.8±0.3	0.006

After Intervention						
Energy (kcal)	82.4 - 1934.8	822.5±349.3	161.0 - 8445.7	994.5±920.8	171.9±105.2	0.106
Protein (g)	2.70 - 318.7	33.4±27.2	8.1 – 65.9	30.8±14.3	2.7±3.2	0.405
Calcium (mg)	5.3 - 478.6	75.1± 58.8	2.5 – 203.3	62.2±41.5	12.9±6.9	0.030
Vitamin D (mcg)	0.0 - 26.7	2.8±2.9	0.0 – 9.9	2.2±2.1	0.6±0.3	0.056
Vitamin A (mcg)	1.8 - 1843.2	166.3±195.6	2.0 - 789.9	145.4±136.2	20.8±23.4	0.375
Folic Acid (mcg)	0.0 186.4	41.4±27.9	2.1 - 142.6	41.7±26.8	0.3±3.5	0.923
Vitamin C (mg)	0.0 - 346.4	8.7±28.6	0.0 - 64.5	8.1±12.8	0.6±3.3	0.853
Vitamin E (mcg)	0.0 – 23.7	2.1±1.9	0.0 – 5.4	2.1±1.4	0.0±0.2	0.850
Iron (mg)	0.3 – 23.0	2.7±2.2	0.3 – 5.8	2.3±1.2	0.4±0.2	0.050
Zinc (mg)	0.3 – 14.5	2.6±1.5	0.4 – 7.5	2.5±1.4	0.1±0.2	0.374

Note : # Analyzed by T independent Test

Table 6: Changes in Parameters of Nutritional Status of Adolescent Girls in Both Study Groups

Variable	Baseline		Endline		Mean Difference	p-value#
	Min-Max	Mean±SD	Min-Max	Mean±SD		
Intervention Group (n = 262)						
Mid Upper Arm Circumference (MUAC). cm#	18.0 - 40.6	23.7±3.6	18.2-38.0	25.3±3.4	1.6±2.4	0.000
Hemoglobin, g/dl#	7.8 - 16.5	12.9±1.3	7.1-16.2	13.1±1.4	0.2±1.0	0.060
BAZ-Score#	-3.22 - 2.79	-0.2±1.2	-3.02-3.1	-0.1±1.2	0.1±0.6	0.091
HAZ-Score#	-3.58 - 1.28	-1.56±0.9	-3.49-0.6	-1.62±0.8	-0.06±0.4	0.020
Hemoglobin Category, n(%)##						
• Anemia	55 (21.0)		46 (17.6)			0.000
• Normal	207 (79)		216 (82.4)			
MUAC category, n(%)##						
• CED	148 (56.5)		85 (32.4)			0.000
• Normal	114 (43.5)		177 (67.6)			
BAZ category, n(%)##						
• Wasting	17 (6.6)		13 (5.0)			0.000
• Normal	243 (93.4)		247 (95.0)			
BAZ category, n(%)##						
• Overweight	39 (15.0)		42 (16.2)			0.000
• Obesity	7 (2.7)		7 (2.7)			
• Normal	221 (85.0)		218 (83.8)			
HAZ category, n(%)##						
• Severe Stunted	12 (4.6)		10 (3.8)			0.000
• Stunted	64 (24.6)		72 (27.7)			
• Normal	184 (70.8)		178 (68.5)			
Comparison Group (n = 80)						
Mid Upper Arm Circumference, cm#	17.0 - 37.5	23.6±2.8	18.4-34.6	25.6±3.1	1.9±2.4	0.000

Hemoglobin, g/dl#	7.0 - 15.5	12.93±1.4	8.1-15.6	12.97±1.3	0.04±1.1	0.763
BAZ-Score#	-2.60 - 1.9	-0.02±0.9	-2.86-1.8	0.01±0.9	0.02±0.4	0.592
HAZ-Score#	-3.68 - (-0.1)	-1.79±0.8	-3.62-(-0.1)	-1.85±0.8	-0.06±0.2	0.031
Hemoglobin Category##						
• Anemia	14 (17.5)		18 (22.5)			0.007
• Normal	66 (82.5)		62 (77.5)			
MUAC category##						
• CED	42 (52.5)		21 (26.3)			0.000
• Normal	38 (47.5)		59 (73.8)			
BAZ category##						
• Wasting	1 (1.3)		2 (2.5)			0.000
• Normal	79 (98.7)		78 (97.5)			
BAZ category##						
• Overweight	12 (15.0)		14 (17.5)			0.000
• Normal	68 (85.0)		66 (82.5)			
HAZ category##						
• Severe stunted	5 (6.3)		6 (7.5)			0.000
• Stunted	28 (35.0)		28 (35.0)			
• Normal	47 (58.8)		46 (57.5)			

Note: #continuous data were analyzed using the independent T test, ##Categorical data were analyzed using the Mc-Nemar test,

This increase had a significant effect on reducing the percentage of female adolescents classified as wasting. However, in the control group, the prevalence of wasting increased significantly. Both groups experienced a significant increase in obesity prevalence (Table 6).

The mean value of the HAZ-score index decreased significantly in both groups, although it remained within the normal category. After the intervention, the mean HAZ score was higher in the intervention group compared to the comparison group. This increase in the mean HAZ score contributed to a significant reduction in the percentage of severe stunting among adolescent girls in the intervention group, compared to the comparison group.

Categorically, there was a trend of improving the nutritional status of female adolescents in the intervention group compared to the control group. We found a decrease in several nutritional status indicators of female adolescents in the intervention group, such as anemia, chronic energy deficiency , wasting, and severely stunted, except for overweight, which increased by 1.2%. Conversely, in the comparison group, only chronic energy deficiency decreased significantly, while the others increased significantly, namely anemia, wasting, severely stunted, and overweight (Table 6).

Discussion

This study assessed the effect of school-integrated interventions to improve adolescent girls' knowledge about health-nutrition and their nutritional status. Before the intervention, the mean value of knowledge in the comparison group was higher than that of the intervention group. It was presumed that the female adolescents in the comparison group have been exposed to nutrition-health information from social media. However, after the intervention, the increase in knowledge of adolescent girls was better in the intervention group than the comparison group, which was marked by an enhancement in the average value of all knowledge items almost two times in the intervention group (13.53 points), compared to the comparison group (7.25 points) significantly (p=0.001) (Table 6). It could be due to the addition of nutrition-health information through counseling received by adolescent girls during the implementation of Posyandu activities at school, so their nutrition-health literacy increased. It proves that the intensity of communication, information, and education (CIE) provided to adolescent girls was more effective in escalating their knowledge. CIE

was considered the most effective way to provide knowledge, disseminate health information, increase awareness, and knowledge, motivate positive behavior changes toward nutrition, and make the right decisions about nutrition issues.[25]

There were also several previous studies regarding the effect of educational interventions on increasing adolescent girls' knowledge, such as in rural China,[26,27] Bangladesh,[28] Pakistan,[29] and Nigeria,[30] even in Indonesia.[31]

Initially, the intake of various nutrients differed significantly between the two groups, except for vitamin D, iron, and zinc. The consumption of these three micronutrients was higher in the intervention group because they consumed animal food more often as a source of these nutrients. For example, they consumed fish and eggs 2-3 times per day (22% and 16.8% respectively), powdered milk once per day (16.4%), and sweetened condensed milk (13.4%). However, after the intervention, only calcium intake was significantly different between the two groups, with female adolescents in the intervention group consuming more calcium. Previous studies showed that Chinese American women who received educational interventions had an impact on increasing calcium intake significantly in the intervention group.[32]

Consumption of food sources of calcium, mainly sourced from milk (milk powder and sweetened condensed milk), can also be influenced by the socio-economic status of an adolescent girl's family. Adolescent girls who come from intervention schools have better family socioeconomic and environmental status than the comparison group (Table 1), so they have better access to consuming calcium sources. This study provides evidence of the significant difference in the employment of parents between the two groups. In the intervention group, fathers and mothers were more employed as civil servants or self-employed, compared to the comparison group. Similarly, there was a substantial contrast in the fathers' education between the two groups. The majority of fathers in the intervention group had more than nine years of education duration, while the majority in the control group only completed a maximum of nine years of education equivalent to primary education.[33]

The socio-economic aspect is a factor that influences the availability of food sources of calcium at home, proven by several previous studies, which showed that calcium intake in adolescents in India was significantly lower in those from lower socio-economic strata compared to high socio-economic strata, both for male and female adolescents $p<0.0005$, where dairy products are the main source of calcium intake for adolescents from high socio-economic classes, while for adolescents from low socio-economic circles, calcium food sources are consumed more from green vegetables.[34] Socio-economic aspects are among the most critical social and environmental factors influencing adolescent calcium intake through the availability of calcium sourced foods in the household.[35]

As is the case with the results of a study of adolescent couples and parents in Asian, Hispanic, and non-Hispanic white also proved that the availability of calcium-rich foods as a social and environmental factor predicts of calcium intake in adolescents.[36] The current study results indicate that the role of education and parental support as social-environmental factors is an aspect that has implications for changes in food and nutrient intake among female adolescents, particularly in terms of calcium-rich food intake. There is a significant difference in calcium-rich foods intake between intervention schools and comparison schools. However, the two study groups showed a decrease in total intake of several nutrients, which might be related to recall bias during the assessment and adolescent preferences. High-quality nutrition education interventions do not guarantee better results because factors of adolescent preference, control of resources, and household dynamics can become obstacles in the context of nutrition education programs.[37]

In terms of nutritional status improvement, integrated interventions significantly improve the nutritional status of adolescent girls because they might significantly reduce malnutrition problems compared to the comparison group, without neglecting the increasing prevalence of obesity in both groups, significantly.

There was a significant reduction in HAZ scores in both groups due to an increase in adolescent age that did not coincide with an increase in optimal height. However, counseling in the intervention group affected the increasing consumption of animal food and processed products which had significant implications for reducing the prevalence of wasting (1.6%) and severe stunting (0.8%) significantly (Table 6). In contrast to the comparison group, the consumption of low animal food resulted in the percentage of wasting and severely stunted increased significantly. Animal foods and their products contain lots of protein and micronutrients (zinc, iron, calcium, vitamin D, vitamin A, etc.) necessary for optimal growth.[38-39]

The prevalence of obesity increased significantly in both groups, due to more than half of female adolescents rarely consuming vegetables as a source of fiber. In contrast, soft drinks containing sugar, especially fructose, were consumed more often by young women in both groups. However, soft drink consumption more frequently in the comparison group resulted in a 2 times higher increase in obesity than the intervention group (Table 6). It means that the provision of interventions in the two groups has not been able to trigger changes in eating behavior, especially those related to the consumption of vegetables because they do not like them. The consumption of ultra-processed foods and drinks rich in sugar (fructose) has become a lifestyle for today's youth because it related to their self-esteem. In line with the 2021 global nutrition report, there was a tendency for the prevalence of obesity to increase in young women (10-19 years), due to an unhealthy diet.[40]

This study is in line with previous research in Zambia regarding a nutrition education intervention program by mentors which had a significant impact on improving the nutritional status of female adolescents aged 10-14 years after one year of intervention, marked by a decrease in the prevalence of stunting by 3.9% (p=0.000), wasting by 1.2% (p=0.029), contrary the prevalence rates of overweight and obesity increased by 4.1% (p=0.000) for overweight and obesity by 0.3% (p=0.344) respectively.[37]

The prevalence of anemia decreased significantly in the intervention group because they received multi-micro-nutrient supplementation plus counseling provided by primary health care officers and community Posyandu cadres on the day of the Posyandu implementation. In addition, the results of a meta-analysis study and systematic review showed that providing school-based multi-micro-nutrient supplements reduced the prevalence of anemia in female adolescents (RR: 0.67; 95% CI: 60-74).[41]

Therefore, the results of this study are vital in contributing to increasing the body of knowledge in the field of public health nutrition because this research is the first to examine the integrated approach school-based in efforts to improve the literacy and nutritional status of adolescent girls through nutrition-health education programs and the integration of nutrition-health services in the female adolescents Posyandu, involving various actors (such as teachers, school health officers, community health center officers, and community Posyandu cadres) and also the community health centers program such as supplementation of multi micronutrients and counseling.

Limitation and Recommendation

The study has some limitations: firstly, the school randomization effect affected the number of students that were not equal between the intervention and comparison schools because there were differences in the number of student populations in each school; secondly, subjects answered the type and amount of food and beverage consumed based on their memory. It could be a source of bias; thirdly, the capacity and seriousness of each teacher in delivering health-nutrition education materials can also be a source of bias in this research.

This study suggests continuing this integrated program in this school, and stakeholders can replicate it in other schools to continue investing in adolescent girls to prevent stunting across generations.

Conclusion

In conclusion, school-integrated interventions were more effective than nutritional education alone in improving nutrition-health knowledge and nutritional status among adolescent girls.

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Conflict of Interest

All authors declare no conflict of interest.

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