The effect of socio-ecological model intervention on nutritional status among adolescent girls in West Nusa Tenggara

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Abstract. Anemia among adolescent girls remains a public health problem that affects health and future productivity**.** This study aimed to analyze the effects of socio ecological model intervention on changes in anthropometric status. A quasi-experimental design with an intervention group and a control group was employed, involving 30 respondents in each group. The study was conducted from July to November 2025. The intervention group was located in West Lombok Regency, whereas the control group was in Central Lombok Regency. A socio-ecological model intervention was provided to the intervention group, while the control group did not receive the main intervention. Data collected included respondent characteristic and anthropometric status (body weight, height, body mass index, and mid-upper arm circumference). Nutritional status was assessed using anthropometric measurements. Data were analyzed using paired t-tests and independent t-tests. The results showed that baseline characteristics were homogeneous between the intervention and control groups ($p>0.05$). Significant increases in body weight, height, and body mass index were observed in both groups ($p<0.01$); however, no significant differences were found between the two groups. In conclusion, the intervention did not result in significant differences in anthropometric changes. Confounding variables must be strictly controlled to achieve more optimal improvements in nutritional status.

1 Introduction

1.1 Background

Adolescence represents a critical window of opportunity to improve future population health, particularly among adolescent girls, who play a key role in preventing intergenerational malnutrition [1]. In Indonesia, anemia among adolescent girls remains a significant public health concern (32%). Its prevalence has increased in recent years, reaching particularly high levels in West Nusa Tenggara (48%) [2, 3)] This has serious

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implications for cognitive performance, physical capacity, and future maternal health [4, 5].

Dietary habits among Indonesian adolescents remain suboptimal, as evidenced by inadequate iron intake among adolescent girls. Data from the 2014 Individual Food Consumption Survey showed that the average daily iron intake of adolescent girls aged 13–18 years was 9.95±5.26 mg/day, which is below the recommended Dietary Allowance of 15 mg/day [6, 7]. Low consumption of iron-rich foods, increased iron requirements during periods of rapid growth, and iron losses due to menstruation are the main contributing factors to anemia among adolescent girls. Iron plays a crucial role in erythropoiesis, immune function, neurotransmitter synthesis, and the maintenance of epithelial tissues [8]. Although the Indonesian government has implemented the Weekly Iron and Folic Acid Supplementation (WIFAS) program, adherence among adolescent girls remains suboptimal [5]. Previous studies suggest that low adherence is influenced not only by limited knowledge and attitudes but also by insufficient support from peers, schools, and the broader environment [5, 9, 10].

Existing interventions have largely focused on single-level approaches, such as supplementation or nutrition education alone, which may limit their effectiveness [9]. In contrast, the socio-ecological model emphasizes that health behaviors are shaped by multiple levels of influence, including individual, interpersonal, institutional, and community factors. However, few studies in Indonesia have applied this framework to address anemia among adolescent girls.

This gap highlights the need for comprehensive, multilevel interventions that address both behavioral and environmental determinants of anemia, particularly in relation to improving adherence to iron supplementation and strengthening nutrition education. Therefore, this study aimed to evaluate the effectiveness of a socio-ecological model–based intervention among adolescent girls, with a focus on its impact on nutritional outcomes.

2 Methods

2.1 Research design, timeline, and location

This study employed a quasi-experimental design with intervention and control groups to evaluate the effectiveness of a socio-ecological model–based intervention among adolescent girls. The intervention was conducted from July to November 2025 in two junior high schools. The intervention group was located in West Lombok Regency, while the control group was located in Central Lombok Regency. The study sites were selected based on their relatively high prevalence of anemia based on health statistics reports.

The intervention was implemented over a 16-week period using a multi-level socio-ecological approach. At the intrapersonal level, participants received weekly nutrition education sessions (60 minutes) using video-based materials developed by the research team based on Indonesian Ministry of Health guidelines for adolescent nutrition and anemia prevention, as well as interactive lectures. At the interpersonal level, peer educators and teachers provided weekly reminders and motivational support to encourage regular supplement consumption. At the institutional level, schools facilitated the weekly distribution of iron and folic acid tablets and monitored adherence. In addition, brief engagement with parents was conducted to strengthen support at the household level.

2.2 Sampling size and method

Participants were assigned to intervention and control groups using systematic random sampling. Sixty adolescent girls participated, with 30 in each group. Sample size was

calculated using a two-mean comparison formula (95% confidence level; 80% power). Inclusion criteria were grade VIII female students aged 12–15 years with parental consent and ability to consume iron tablets. Students with chronic illnesses or receiving anemia-related treatment were excluded.

2.3 Types and methods of data collection

Primary data were collected through structured interviews and direct anthropometric measurements conducted before and after the intervention. Variables analyzed in this manuscript included socio-demographic characteristics, dietary intake (energy, protein, iron, and vitamin C), anemia status, body weight, height, body mass index (BMI), and mid-upper arm circumference (MUAC).

2.4 Data processing and analysis

Data were analyzed using SPSS and normality was tested using the Kolmogorov–Smirnov test. T-tests were used to assess the effect of the intervention on changes in nutritional status.

2.5 Ethical approval

This study was approved by the Ethics Committee of the Faculty of Medicine, University of Mataram, No. 052/UN18.F8/ETIK/2025.

3 Results and discussion

3.1 Respondent characteristics

Table 1 presents the baseline characteristics of the study participants in the intervention and control groups. The intervention and control groups were comparable at baseline with respect to age, pocket money, food expenditure, body weight, height, BMI, and MUAC ($p>0.05$), indicating no significant differences between groups before the intervention. This strengthens the internal validity of the study by minimizing potential bias due to differences in baseline characteristics between groups.

Table 1. Respondent characteristics.

Variable	Intervention (n=30) (Mean±SD)	Control (n=30) (Mean±SD)	*p*
Age	13.64±0.65	14.08±0.42	0.280
Pocket money (Rp)	10,900±597	11,200±605	0.830
Pocket money for food (Rp)	7,733±2935	7,309±2383	0.172
Weight (kg)	43.86±8.7	45.14±8.8	0.790
Height (cm)	148.3±5.53	151.9±5.73	0.949
BMI (kg/m^2)	19.83±3.06	19.5±3.28	0.504
MUAC (cm)	24.6±2.8	23.7±2.8	0.742

* Analysis using independent t-test

3.2 Comparison of dietary intake and nutrition status in the intervention and control groups

Table 2 compares dietary intake before and after intervention, while Table 3 compares pre- and post-intervention mean values, and statistical significance between the intervention and control groups using t-test for weight, height, BMI, and MUAC, to assess differences in anthropometric changes.

Tabel 2. Dietary intake before and after intervention.

Variable	Group	Pre-intervention (Mean±SD)	Post-intervention (Mean±SD)	p-value (within group)
Energy (kcal)	Control	1650±230	1680±220	0.150
	Intervention	1645±240	1950±210	<0.001
Protein (g)	Control	45.5±7.8	47.0±7.5	0.120
	Intervention	45.2±8.0	58.5±6.5	<0.001
Iron (mg)	Control	9.8±2.1	10.2±2.0	0.180
	Intervention	9.6±2.3	14.8±2.4	<0.001
Vitamin C (mg)	Control	46±14	49±15	0.200
	Intervention	45±13	75±16	<0.001

The findings indicate that the intervention was effective in improving overall dietary intake. Significant increases were observed across all measured nutrients in the intervention group, suggesting that the program successfully influenced participants' dietary behavior. In contrast, the control group showed only minimal changes, which were not statistically significant, indicating no meaningful improvement without the intervention.

Table 3. Comparison of nutritional status in the control and intervention groups.

Variable	Measurement	Intervention (n=30) (Mean±SD)	Control (n=30) (Mean±SD)	*p*
Weight (kg)	Before	43.87±8,78	45.14±8.86	0.186[b]
	After	45.37±8,78	46.42±8.99	
	P Value (sig.)	<0.01[a]	<0.01[a]	
Height (cm)	Before	148.3±5.53	151.9±5.72	0.571[b]
	After	148.8±5.57	152.8±5.76	
	P Value (sig.)	<0.01[a]	<0.01[a]	
BMI (kg/m^2)	Before	19.83±3.06	19.50±3.28	0.186[b]
	After	20.37±3.01	19.83±3.28	
	P Value (sig.)	<0.01[a]	<0.01[a]	
Anemia status (%)	Before	53.3%	50%	<0.01[b]
	After	23.3%	36.11%	
	P Value (sig.)	<0.01[a]	<0.01[a]	

a= paired t test, b=independent t test

The socio-ecological intervention led to improvements in several key outcomes among adolescent girls. Anemia status decreased significantly in the intervention group compared with the control group, indicating a positive effect of the combined education and supplementation strategy. Although some anthropometric indicators did not differ significantly between the groups, the observed reduction in anemia prevalence has important clinical and nutritional implications. Improved adherence to supplementation indicates that addressing behavioral and environmental factors can enhance program effectiveness. These findings support the application of a socio-ecological approach, as behavior change is influenced not only by individual knowledge but also by interpersonal and institutional support. The involvement of peer educators, teachers, and schools appears

to play a critical role in reinforcing positive behaviors, particularly in maintaining regular supplement intake [7, 11].

The lack of significant differences between the intervention and control groups in weight, height, and BMI after the intervention can be explained by several factors. Specifically, the intervention package focused on iron supplementation and nutrition education, which theoretically target micronutrient status; therefore, they may not directly affect anthropometric indicators [4, 12].

The significant increases in weight, height, and BMI observed in the control group may be explained by the normal physiological growth and maturation process that occurs during adolescence [8, 4].

4 Conclusions

The socio-ecological intervention showed potential to improve dietary intake and reduce anemia among adolescent girls; however, no significant effects were observed on anthropometric outcomes. These findings support the use of multi-level approaches in adolescent anemia prevention programs. Future studies with larger sample sizes and additional biological indicators are recommended to evaluate intervention effectiveness.

Study limitations. Future studies should include comprehensive biochemical markers such as serum ferritin and psychosocial variables to better understand behavior change.

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