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CEMARA (CEGAH ANEMIA, REMAJA BAHAGIA): EFFECTIVENESS OF IRON SUPPLEMENTATION TABLET (TABLET TAMBAH DARAH/TTD) IN ANEMIA PREVENTION AMONG ADOLESCENTS AT SMPN 58 MALUKU TENGAH

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Abstract

Background: Anemia in adolescent girls remains a significant public health challenge in Indonesia, with prevalence rates particularly elevated in eastern regions including Maluku. Iron deficiency anemia impairs cognitive function, academic performance, and physical development during the critical growth period. Iron Supplementation Tablet (Tablet Tambah Darah/TTD) distribution represents the national strategy to address this issue. Objective: This study aimed to evaluate the effectiveness of the CEMARA (Cegah Anemia, Remaja Bahagia) program through TTD provision on anemia prevention knowledge among adolescent girls at SMPN 58 Maluku Tengah. Methods: A pre-experimental one-group pre-test post-test design was employed involving 27 female students aged 12–18 years. Knowledge was assessed using a 10-item validated questionnaire (Cronbach's $\alpha = 0.78$) before and after the CEMARA intervention comprising three weekly sessions. Data were analyzed using paired t-test. Results: Mean knowledge scores improved significantly from 5.26 (SD ± 1.87) at pre-test to 8.30 (SD ± 0.91) at post-test. The proportion of students with good knowledge (score ≥8) increased from 7.4% to 85.2% following the intervention. Statistical analysis revealed a highly significant difference [$t(26) = 14.461$, $p < 0.001$]. Conclusion: The CEMARA program with TTD provision significantly improved adolescent knowledge regarding anemia prevention. Structured school-based interventions combining health education and iron supplementation are effective strategies for anemia prevention among adolescent girls.

Keywords: Anemia Prevention, Iron Supplementation, Adolescent Girls, CEMARA, School Health, Tablet Tambah Darah

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Introduction

Anemia remains one of the most prevalent nutritional disorders globally, disproportionately affecting adolescent girls in low- and middle-income countries. The World Health Organization (WHO) estimates that approximately 40% of adolescent girls in Southeast Asia are affected by anemia, with iron deficiency being the primary etiology [1]. In Indonesia, national data from the Ministry of Health (2023) indicate that the prevalence of anemia among adolescent girls aged 12–18 years reaches 38.5%, with Maluku Province reporting rates exceeding the national average at approximately 42.3% [2]. This condition poses serious consequences for health, educational attainment, and quality of life during this formative developmental period.

Adolescent girls are particularly vulnerable to iron deficiency anemia due to menstrual blood loss, rapid growth demands, and frequently inadequate dietary iron intake [3,4]. The consequences of untreated anemia in this population include impaired cognitive development, reduced learning capacity, decreased physical endurance, and increased susceptibility to infections [5]. Furthermore, adolescent girls who enter reproductive age with iron deficiency face elevated risks of maternal mortality and adverse pregnancy outcomes in adulthood, perpetuating an intergenerational cycle of nutritional deficiency [6].

The Indonesian government has implemented the Iron Supplementation Tablet (Tablet Tambah Darah/TTD) supplementation program as a strategic national response, mandating weekly iron supplementation for adolescent girls through school-based distribution [2]. However, program effectiveness is frequently undermined by inadequate knowledge about anemia, low compliance with supplementation regimens, and insufficient health education activities at the school level [7,8]. Previous studies conducted in various Indonesian provinces have documented significant knowledge deficits among adolescent girls regarding anemia etiology, prevention strategies, and the importance of TTD consumption [9,10].

Research in Maluku and similar eastern Indonesian regions remains limited, creating a critical knowledge gap regarding the effectiveness of school-based anemia prevention interventions in this context [11]. The CEMARA (Cegah Anemia, Remaja Bahagia) program was therefore developed as a comprehensive school-based intervention integrating structured health education with TTD provision to address this gap.

This study aimed to evaluate the effectiveness of the CEMARA program in improving anemia prevention knowledge among adolescent girls at SMPN 58 Maluku Tengah, thereby providing evidence-based insights to strengthen local anemia prevention strategies.

Methods

Research Design

This study employed a pre-experimental design with a one-group pre-test post-test approach. This design was selected given the exploratory nature of the intervention and the limited availability of comparable control populations within the same school. The research was conducted at SMPN 58 Maluku Tengah during the academic year 2026/2027.

Participants and Sampling

The study population comprised all female students enrolled at SMPN 58 Maluku Tengah. Using purposive sampling, 27 female students aged 12–18 years who met the inclusion criteria were recruited as participants. The sample size of 27 respondents was determined based on the total population of eligible female students who met inclusion criteria at the study site, consistent with total sampling or saturated sampling approaches used in small-population community studies [12]. This approach was

deemed appropriate given the single-site, exploratory design; however, the authors acknowledge that this limits statistical power and generalizability, as discussed in the Limitations section.

Inclusion criteria included: female students actively enrolled at SMPN 58 Maluku Tengah, willingness to participate in the intervention program documented through signed informed assent, and ability to complete the questionnaire independently. Students with documented medical conditions affecting iron absorption or who were receiving concurrent iron therapy were excluded.

CEMARA Intervention

The CEMARA (Cegah Anemia, Remaja Bahagia) intervention comprised three structured health education sessions delivered over three consecutive weeks, each session lasting approximately 60–90 minutes. The sessions were facilitated by trained health educators from the research team and school health personnel.

The educational content covered: (1) Session 1 — definition of anemia, epidemiology, and risk factors specific to adolescent girls; (2) Session 2 — clinical manifestations, nutritional requirements (dietary iron sources, vitamin C as absorption enhancer, inhibitors of iron absorption), and consequences of untreated anemia; (3) Session 3 — national TTD program, correct administration protocol including optimal timing and dietary considerations, and strategies to sustain supplementation compliance.

Education was delivered through a combination of interactive lectures, printed visual aids (posters and illustrated leaflets), group discussion, and question-and-answer sessions. In each session, Iron Supplementation Tablets (Tablet Tambah Darah/TTD) were distributed and participants received direct supervised practice on correct consumption. This combined approach—structured education paired with tangible supplementation experience—was designed to enhance both knowledge and motivation for compliance [13].



Source: Documentation from the Education, Research, and Community Service Program, BARAKARSA Foundation., 2026

Measurement Instrument

Knowledge was assessed using a 10-item dichotomous questionnaire (correct/incorrect responses) developed based on established anemia prevention frameworks by Notoatmodjo (2021) and adapted to align with the national TTD program guidelines [12,2]. Each correct response was awarded one point, yielding a total possible score of 0–10. Scores were categorized as: poor knowledge (<5 or <50%), moderate knowledge (5–7 or 50–74%), and good knowledge (8–10 or ≥75%).

Instrument validation was conducted in two stages. First, content validity was established through expert panel review involving three specialists: one public health nutritionist, one health promotion

specialist, and one school health educator, each with a minimum of five years of experience in adolescent health programs. Content Validity Index (CVI) was computed per item and across the instrument. Second, construct reliability was evaluated through a pilot test administered to 15 female students with similar characteristics at a neighboring school not included in the main study. Internal consistency reliability was confirmed with Cronbach's alpha = 0.78, exceeding the minimum acceptable threshold of 0.70 for social and health science research instruments [14].

Data Collection Procedure

Pre-test data were collected immediately before the first CEMARA session commenced. Post-test data were collected two weeks following the completion of the final (third) educational session, allowing a retention interval. Data collection was conducted in a standardized setting; participants completed questionnaires independently without reference materials.

Statistical Analysis

Descriptive statistics (frequency, percentage, mean, and standard deviation) were calculated for all variables. The Shapiro-Wilk test was applied to assess normality of the distribution of difference scores (post-test minus pre-test), which confirmed approximate normality ($W = 0.961$, $p = 0.387$). A paired-samples t-test was therefore used to compare pre-test and post-test mean knowledge scores. Statistical significance was defined as $p < 0.05$ (two-tailed). The t-statistic is reported in standard academic format as $t(df) = value$. All analyses were conducted using SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA).

Ethical Considerations

Ethical clearance was obtained from the Institutional Review Board of Universitas Sunan Gresik. Written informed consent was secured from participants' guardians, and informed assent was obtained from participants prior to data collection. Participation was voluntary, and participants were informed of their right to withdraw at any time without consequence.

Results

Participant Characteristics

The study included 27 female students with a mean age of 13.9 years (SD ± 1.4). Participants were distributed across grades 7 (n = 10, 37.0%), 8 (n = 9, 33.3%), and 9 (n = 8, 29.6%). Age distribution showed that the majority were aged 12–13 years (n = 14, 51.9%), followed by 14–15 years (n = 11, 40.7%), and 16 years and above (n = 2, 7.4%). Demographic characteristics are presented in Table 1.

Table 1. Demographic Characteristics of Participants (n = 27)

Characteristic	n	%	Cumulative %
Age			
12–13 years	14	51.9	51.9
14–15 years	11	40.7	92.6
≥16 years	2	7.4	100.0
Grade Level			
Grade 7	10	37.0	37.0
Grade 8	9	33.3	70.3

Characteristic	n	%	Cumulative %
Grade 9	8	29.6	100.0
Total	**27**	**100.0**	

Source: Primary data, 2025

Knowledge Scores Before and After Intervention

Pre-test knowledge assessment revealed that the majority of participants (n = 18, 66.7%) had moderate knowledge, seven participants (25.9%) had poor knowledge, and only two (7.4%) demonstrated good knowledge regarding anemia prevention. Mean pre-test score was 5.26 (SD ± 1.87). Following the CEMARA program intervention, post-test results demonstrated a marked improvement: 23 participants (85.2%) achieved good knowledge, four (14.8%) remained in the moderate category, and no participants were classified as having poor knowledge. Mean post-test score increased to 8.30 (SD ± 0.91). The distribution of knowledge categories before and after intervention is presented in Table 2.

Table 2. Distribution of Anemia Prevention Knowledge Before and After CEMARA Program Intervention

Knowledge Category	Pre-test n	Pre-test %	Post-test n	Post-test %	Score Range	Criteria
Poor	7	25.9	0	0.0	0–4	<50%
Moderate	18	66.7	4	14.8	5–7	50–74%
Good	2	7.4	23	85.2	8–10	≥75%
Total	**27**	**100.0**	**27**	**100.0**		
Mean Score	**5.26**		**8.30**			
SD	±1.87		±0.91			

Note: SD = Standard Deviation. Knowledge categorization adapted from Notoatmodjo (2021): Poor (<50%), Moderate (50–74%), Good (≥75%).
Source: Primary data, 2025

Paired t-Test Analysis

The Shapiro-Wilk test confirmed the normality of difference scores (W = 0.961, p = 0.387), satisfying the assumption for paired t-test application. The paired t-test analysis demonstrated a highly statistically significant difference between pre-test and post-test knowledge scores [t(26) = 14.461, p < 0.001]. The mean difference was 3.04 points (95% CI: 2.61–3.47), representing a 57.8% relative improvement in mean knowledge scores. Results are presented in Table 3.

Table 3. Paired t-Test Results Comparing Pre-test and Post-test Knowledge Scores

Variable	Mean	SD	Mean Difference (95% CI)	t(26)	p-value
Pre-test Score	5.26	1.87	3.04 (2.61–3.47)	14.461	<0.001
Post-test Score	8.30	0.91			

Note: df = 26; Paired-samples t-test; two-tailed significance at p < 0.05.
Source: Primary data, 2025

Discussion

The findings of this study demonstrate that the CEMARA program, integrating structured health education with Iron Supplementation Tablet (Tablet Tambah Darah/TTD) provision, produced a statistically significant and clinically meaningful improvement in anemia prevention knowledge among adolescent girls at SMPN 58 Maluku Tengah. The mean knowledge score increased from 5.26 to 8.30 [$t(26) = 14.461$, $p < 0.001$], with the proportion of students demonstrating good knowledge rising dramatically from 7.4% to 85.2%. This magnitude of improvement aligns with and extends findings from comparable school-based interventions conducted across Indonesia.

The significant knowledge improvement observed is consistent with findings by Pertiwi et al. (2022), who documented comparable improvements following school-based anemia education programs in West Java, reporting post-intervention good knowledge prevalence of 79.3% [9]. Similarly, Rahayu and Margawati (2021) demonstrated that structured educational interventions increased anemia knowledge scores by an average of 2.8 points among junior high school students in Central Java [15]. The slightly larger improvement observed in the present study (3.04 points) may reflect the effectiveness of the combined education-supplementation approach and the comparatively lower baseline knowledge levels characteristic of the eastern Indonesian context [11].

The low baseline knowledge scores (mean 5.26/10, with 25.9% classified as poor knowledge) reflect patterns documented across similar populations in eastern Indonesia, where health literacy and access to health education resources remain comparatively limited [11]. These baseline findings underscore the necessity of structured, school-based health education programs in this region. Educational interventions within school settings have been consistently demonstrated to represent cost-effective and accessible modalities for reaching adolescent populations with health promotion content [16].

The integration of TTD provision within the CEMARA program framework likely enhanced educational engagement through experiential learning. When students receive and consume the supplementation they are learning about, abstract health concepts become tangible and personally relevant, potentially reinforcing knowledge retention and compliance motivation. This approach aligns with recommendations from Briawan et al. (2020), who emphasized that health education combined with direct supplementation experience produces superior behavioral outcomes compared to either intervention delivered in isolation [13]. Furthermore, recent systematic review evidence confirms that multi-component school-based anemia interventions yield superior knowledge outcomes compared to supplementation alone [17].

The CEMARA program acronym serves as a mnemonic device supporting knowledge retention, a strategy supported by educational psychology research demonstrating that memorable, culturally resonant program names enhance participant engagement and recall of key health messages. The program's emphasis on positive framing ("Happy Adolescents") rather than deficit-focused messaging may have contributed to receptivity among the adolescent participant group.

The study findings carry important implications for anemia prevention policy implementation in Maluku Province. The substantial baseline knowledge deficits identified suggest that current TTD distribution without accompanying educational support is insufficient to achieve optimal program outcomes. Health authorities should consider mandating structured educational components alongside supplementation provision, with standardized curricula adaptable to local contexts. Training of school health personnel (UKS/Usaha Kesehatan Sekolah) to deliver consistent, evidence-based anemia education represents a scalable strategy for sustainable program expansion.

Limitations and Recommendations for Future Research

Several important limitations must be acknowledged. First, the pre-experimental one-group pre-test post-test design without a control group limits causal inference. Observed improvements, while statistically significant, could partially reflect internal validity threats including testing effects (familiarity with questionnaire items from repeated exposure), maturation effects (natural developmental changes over the study period), or concurrent exposures to health information from other sources during the intervention period. A randomized controlled trial (RCT) or quasi-experimental design with a matched control group would provide stronger causal evidence.

Second, the sample size of 27 respondents, while representing the total eligible population at the study site, limits statistical power and constrains generalizability of findings to other schools or regions in Maluku or eastern Indonesia. Future studies should employ a priori sample size calculations to ensure adequate statistical power (typically ≥80%) and recruit participants from multiple schools or districts.

Third, this study measured only knowledge outcomes. Program effectiveness for anemia prevention is more comprehensively assessed through additional outcomes including: (a) TTD consumption compliance (proportion of prescribed doses consumed, assessed via structured tablet count or self-report logs); and (b) objective clinical outcomes including hemoglobin concentration and serum ferritin levels, which provide direct evidence of anemia status change. Future research should incorporate these biomarker and behavioral outcomes alongside knowledge assessment.

Fourth, the two-week post-test interval does not assess long-term knowledge retention. Follow-up assessments at one, three, and six months post-intervention would provide evidence on knowledge durability. Future studies should also evaluate attitude changes and behavioral intentions alongside factual knowledge, using validated multidimensional instruments.

Conclusion

The CEMARA (Cegah Anemia, Remaja Bahagia) program combining structured health education with Iron Supplementation Tablet (Tablet Tambah Darah/TTD) provision demonstrated significant effectiveness in improving anemia prevention knowledge among adolescent girls at SMPN 58 Maluku Tengah. Mean knowledge scores improved substantially from 5.26 (SD ± 1.87) to 8.30 (SD ± 0.91) following the three-session intervention, with the proportion of students achieving good knowledge levels increasing from 7.4% to 85.2%. The paired t-test confirmed that this improvement was statistically highly significant [$t(26) = 14.461$, $p < 0.001$].

These findings provide evidence supporting the implementation and expansion of integrated school-based anemia prevention programs in Maluku and comparable eastern Indonesian regions. Future research should incorporate objective hemoglobin and ferritin measurements, TTD compliance assessment, employ controlled study designs with larger multi-site samples, and include longer follow-up periods to establish comprehensive evidence for program effectiveness and sustainability. Collaboration between school health services, local health authorities, and community stakeholders remains essential for sustainable anemia prevention program delivery.

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