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RESEARCH ARTICLE

The Effect of Local Language-Based Nutrition Education and Iron Tablet Supplementation on Changes in Hemoglobin Levels among Adolescent Girls in Boven Digoel District, South Papua

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ABSTRACT

Adolescents face malnutrition, including anemia, due to insufficient iron intake. In Indonesia, especialy in Papua Province, prevalence of anemia among this age group remains high. This study aimed to local language-based nutrition education on Hb levels. This study aimed to local language-based nutrition education on Hb levels among adolescent girls in Boven Digoel District, South Papua, Indonesia. A quasi-experimental study with a non-randomized pre-post test control design. These participants will be divided into two groups: the intervention group and the control group. The population in this study consists of female adolescents in grades VII to IX from two junior high schools. At total of 60 respondent involved in the study which divided into 30 respondent for each intervention and control group. Intervention group received local language based nutrition education for 4 weeks and iron supplementation were received to both group. Mann-whutney and willcoxon test used to analyse data. There was no significant different of knowledge and Hemoglobin level change between group (P-value > 0,05), However, after intervention, knowledge and Hemoglobin level among intervention grou[significantly increase (P-value < 0,05) compare to control group (P-value > 0,05). Conclusion: Local language-based nutrition education significantly improved adolescent girls' knowledge and Hb compared to iron supplementation alone.

1. INTRODUCTION

Adolescents aged 10–19 years face a triple burden of malnutrition, including undernutrition, overnutrition, and micronutrient deficiencies. This period is characterized by significant physical, sexual, and hormonal changes, which can trigger health issues such as anemia. Anemia, defined as hemoglobin (Hb) levels below 12 g/dL, is common among adolescent girls due to inadequate consumption of iron-rich foods and irregular menstrual patterns. This condition results in adolescent girls losing twice as much iron as boys (WHO, 2022; UNICEF, 2021; Ministry of Health Indonesia, 2021; Kumalasari et al., 2019; Yunita et al., 2020). Globally, anemia affects 33% of the population, with a prevalence of 29.9% among women of reproductive age (WHO, 2021; Sekiguchi et al., 2022). In Asia, 191 million adolescent girls are anemic, including 7.5 million in Indonesia, which ranks 8th among 11 Asian countries (WHO, 2011; Sari, 2020).

In Indonesia, the prevalence of anemia among adolescent girls was 26.5% in 2020, decreasing to 15.5% in 2023 (Ministry of Health Indonesia, 2021; Ministry of Health, 2023). However, in Papua, anemia prevalence among women of reproductive age remains high, from 46% in 2018 to 34% in 2020 (Provincial Health Office Papua, 2021). Screening at Ujungkia Junior High School revealed that 68.18% of female students were anemic due to insufficient knowledge and inadequate distribution of iron supplements. Despite 76.2% of adolescent girls receiving iron supplements, adherence remains low (Ministry of Health, 2018). Anemia negatively impacts focus, physical fitness, and growth (Nasruddin et al., 2021). Interventions such as consuming iron- and vitamin C-rich foods have proven effective in enhancing iron absorption (Tahir et al., 2020). Regular education and monitoring by healthcare professionals are essential to improve iron adherence. Collaboration among schools, community health centers, and stakeholders is crucial to combat anemia (Silitonga et al., 2023; Yudina et al., 2020).

Culturally tailored educational media, such as posters or videos in local languages, have proven effective in increasing knowledge among adolescents in remote areas (Sumartono & Astuti, 2018; Firmansyah et al., 2022; Parimayuna et al., 2023). Studies indicate that visually engaging media using local languages can help adolescents better understand health information. Therefore, such media offer a promising solution to raise awareness and adherence among adolescent girls in preventing anemia. Culturally based education represents a strategic approach to reducing anemia prevalence in Indonesia.

2. MATERIALS AND METHODS

The research method employed is a quantitative type, specifically a quasi-experimental design with a two-group pre-test and post-test control group design. The research was conducted at Junior High School Ujungkia and Junior High School 1 Jair, Boven Digoel District, South Papua.

2.1 Population and sample

The population in this study consists of female adolescents in grades VII, VIII, and IX at Junior High School Ujungkia and Junior High School 1 Jair who meet the inclusion criteria. Based on the sample calculation formula, the sample size was determined to be 27 respondents, with an additional 3 respondents as a reserve, resulting in 30 respondents for both the experimental and control groups. Therefore, the total sample size is 60 respondents. These participants will be divided into two groups: the intervention group and the control group. The intervention group will receive nutrition education based on local language and Iron tablets, while the control group will only receive iron supplementation without any education.

2.2 Inclusion criteria

- 2.2.1 Female students aged 10-19 years
- 2.2.2 Female students who have menstruated
- 2.2.3 Female students willing to participate as respondents

2.3 Exclusion criteria

- 2.3.1 Female students who transfer schools during the study period
- 2.3.2 Female students diagnosed with infectious diseases
- 2.3.3 Female students who do not complete the study process
- 2.3.4 Female students who withdraw due to serious illness, death, or other urgent and important reasons.

2.4 Data collecting

- 2.4.1 **Explanation and consent:** Explain the research and its procedures to the subjects, and request their willingness to participate in the study by signing the consent form to complete the research series.
- 2.4.2 **Hemoglobin (Hb) screening:** Conduct Hb level screening for female adolescents in grades VII, VIII, and IX at both research locations one day prior to providing education and iron supplementation during the first week. The Hb measurement procedure using the Hemoglobin Meter Quick-Check involves: a. Clean the fingertip of the ring or middle finger using a cotton pad soaked in 70% alcohol. b. Prick the cleaned fingertip with a blood lancet. c. Allow the blood to drop onto the Hb strip in the Hemoglobin Meter Quick-Check device. d. Wait for the reading to appear on the device and record it as the hemoglobin level.
- 2.4.3 **Pre-Test and interview:** Distribute pre-test sheets to each respondent and interview them using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) form one day before providing education and iron supplementation in the first week.
- 2.4.4 **Nutrition education and iron supplementation for the intervention group:** a. Gather the intervention group every Friday in a designated room for education, iron supplementation, and monitoring card distribution. b. Education is delivered in the local language using posters to facilitate understanding, as the respondents primarily communicate in the local language.

The visual aids in the posters reinforce the message and help respondents retain the information. This aligns with the findings of Sumartono & Hani Astuti (2018), which concluded that posters are effective health communication tools due to their attractive design, including images, colors, and concise messages. c. Education begins on the first Friday and is repeated weekly for one month to maintain consistency and allow participants to absorb and apply the information. Repetition reinforces knowledge and promotes new habits, as supported by Nur Intania Sofianta et al. (2018), who demonstrated significant improvements in knowledge (12.17%, p=0.000), attitudes (3.6%, p=0.000), and behaviors (8.07%, p=0.000) after weekly 60-minute nutrition education sessions over a month. d. Each session lasts 45 minutes, including a 15-minute Q&A session to prevent boredom. e. Three A3-sized posters (29.7 cm x 42 cm) are used, each focusing on different topics:

Poster 1: Definition, causes, and impacts of anemia.

Poster 2: Prevention methods.

Poster 3: Side effects and how to obtain iron supplements. Each poster is explained in 15 minutes. f. After the education session, each respondent is given one iron tablet to consume immediately under supervision. Respondents experiencing menstruation are provided one tablet daily during their menstrual period to be consumed at home. Monitoring cards are maintained and filled out by respondents after each iron intake.

2.4.5 **Iron supplementation for the control group:** a. The control group is gathered weekly in a classroom during recess. Iron tablets are consumed with mineral water provided by the researchers. b. During the first week, each respondent is given one tablet to consume immediately under supervision, and they maintain their monitoring cards. c. Subsequent supplementation is conducted weekly until the fourth week.

2.4.6 **Post-test and interview:** Distribute post-test sheets to each respondent and conduct interviews using the SQ-FFQ form.

2.4.7 **Haemoglobin measurement and post-test:** Measure hemoglobin levels and conduct post-tests for each respondent one day after completing four weeks of iron supplementation.

2.5 Data analysis

The data from this study were analyzed using SPSS. The univariate data analyzed in this study included respondent information such as age, grade, menstruation duration, father's occupation, mother's occupation, father's income, mother's income, and adolescent girls' adherence to consuming iron supplements, which were presented in the form of frequency distributions and percentages for each variable. For bivariate analysis, the Wilcoxon test was used to determine the differences in pre- and post-test knowledge and dietary patterns, while the Mann-Whitney test was used to assess changes in knowledge and dietary patterns before and after the intervention, as the data were not normally distributed. Additionally, the paired t-test was used to analyze the difference in hemoglobin (Hb) levels between the intervention and control groups, while the independent t-test was used to assess the differences in pre- and post-test Hb levels, as the data were normally distributed. Primary data collected included identity data, knowledge, dietary patterns related to iron sources, and hemoglobin levels for each sample. Identity data were obtained by distributing questionnaires to adolescent girls, while knowledge regarding anemia and TTD was assessed through pre- and post-tests. Dietary patterns related to iron sources were obtained through interviews using the SQ-FFQ form, and hemoglobin levels were measured using a Hemoglobin Meter Quick-Check device at both pre- and post-intervention stages. Secondary data were obtained from relevant institutions, providing an overview of the study locations and the number of students at each location.

3. RESULTS

3.1 Univariate analysis

Table 1. Characteristics of parents of adolescent girls in both groups

Variables	Treatment Group		Control Group		Total		P-Value
	n	%	n	%	n	%	
Father Occupations							
Not working	4	13.3	0	0.0	4	6.7	0.022
Private employee	3	10.0	10	33.3	13	21.7	

Civil Servant	11	36.7	7	23.3	18	30.0	
Farmer	9	30	7	23.3	16	26.7	
Fisherman	3	10	2	6.7	5	8.3	
Entrepreneur	0	0	4	13.3	4	6.7	
Mother Occupations							
Not working	16	53.3	22	73.3	38	63.3	0.151
Private employee	4	13.3	0	0	4	6.7	
Civil Servant	0	0.0	1	3.3	1	1.7	
Farmer	9	30.0	5	16.7	14	23.3	
Fisherman	1	3.3	1	3.3	2	3.3	
Entrepreneur	0	0.0	1	3.3	1	1.7	
Family Income							
Low Income (< 2 million)	12	40	7	23	19	31.7	0.133
Middle Income (2-10 million)	18	60	23	76.7	41	68.3	

*Chi-Square test

Based on Table 1, the characteristics of adolescent girls show that the majority of respondents were aged 13–15 years, accounting for 63.3% of the total respondents. The percentage of respondents aged 13–15 years was higher in the control group (70.0%) compared to the intervention group (56.7%). Meanwhile, 23.3% of respondents were aged 10–12 years, and 13.3% were aged 16–18 years. There was no significant difference in the age distribution between the two groups (p = 0.486). In terms of fathers' occupations, the majority in the intervention group were civil servants (36.7%), followed by farmers (30.0%) and unemployed individuals (13.3%). In the control group, a higher proportion of fathers worked as private employees (33.3%) compared to the intervention group (10.0%). Conversely, the intervention group had a higher proportion of fathers working as civil servants (36.7%) compared to the control group (23.3%). Statistical analysis revealed a significant difference in the distribution of fathers' occupations between the two groups (p = 0.022). Regarding mothers' occupations, most respondents' mothers were housewives or unemployed (63.3%), with smaller proportions working as farmers (23.3%), private employees (6.7%), and fishers (3.3%). The difference in the distribution of mothers' occupations between the two groups was not statistically significant (p = 0.151).

Family income data indicated that the majority of respondents' families belonged to the middle-income category, earning between 2 and 10 million rupiah per month. The results showed that 68.3% of families were in the middle-income group, while 31.7% were in the low-income category, earning less than 2 million rupiah per month. Although the difference in income distribution was statistically insignificant (p = 0.133), the data suggest that income level plays a role in the economic characteristics of respondents' families. These findings indicate that most families in the study area had relatively stable economic conditions, although a small proportion remained in the low-income category. Cross-tabulation statistical analysis using the Chi-square test indicated no significant differences in age, mothers' occupations, and family income characteristics between the two groups, suggesting homogeneity of these variables at the beginning of the study (p > 0.05). However, the distribution of fathers' occupations showed significant variation between the two groups, indicating non-homogeneity (p = 0.022).

Table 2: Overview of adherence to iron supplement consumption in both groups

Number of Blood Supplement Tablets Consumed	Groups				P-Value*
	Treatment		Control		
	n	%	n	%	
3 tablets	5	16,67	7	23,33	0.492
4 tablets	25	83,33	23	76,67	
Total	30	100,00	30	100,00	

*Mann-Whitney test

Based on Table 2, which presents the adherence to iron tablet consumption in both groups, it was observed that the most commonly consumed number of tablets during the study was 4 tablets. This was reported by 25 adolescent girls (83.33%) in the intervention group and 23 adolescent girls (76.67%) in the control group. The adherence analysis, using the Mann-Whitney U test, revealed no significant difference between the intervention and control groups, with a p-value of 0.492. This indicates that adherence to iron tablet consumption in this study was homogeneous across both groups.

Table 3: Overview of anemia incidence frequency in pre- and post-test both groups

Groups	Period	Mean Hb (g/dL)	%Hb Normal	%Anemia
Treatment	Pre-test	11.20	40	60
	Post-test	12.45	93.3	6.7
	%Efectivity	13.83	133.25	-88.83
Control	Pre-test	12.75	46.7	53.3
	Post-test	12.65	86.7	13.3
	%Efectivity	0.78	85.65	-75.04

Table 3 demonstrates a significant reduction in anemia prevalence in both groups following iron supplementation. The decrease in anemia cases ranged from 88% to 75%, leaving only 6.7–13.3% of cases by the end of the study. The greatest improvement in anemia reduction was observed in the intervention group, with an effectiveness rate of 13.83%, compared to the control group.

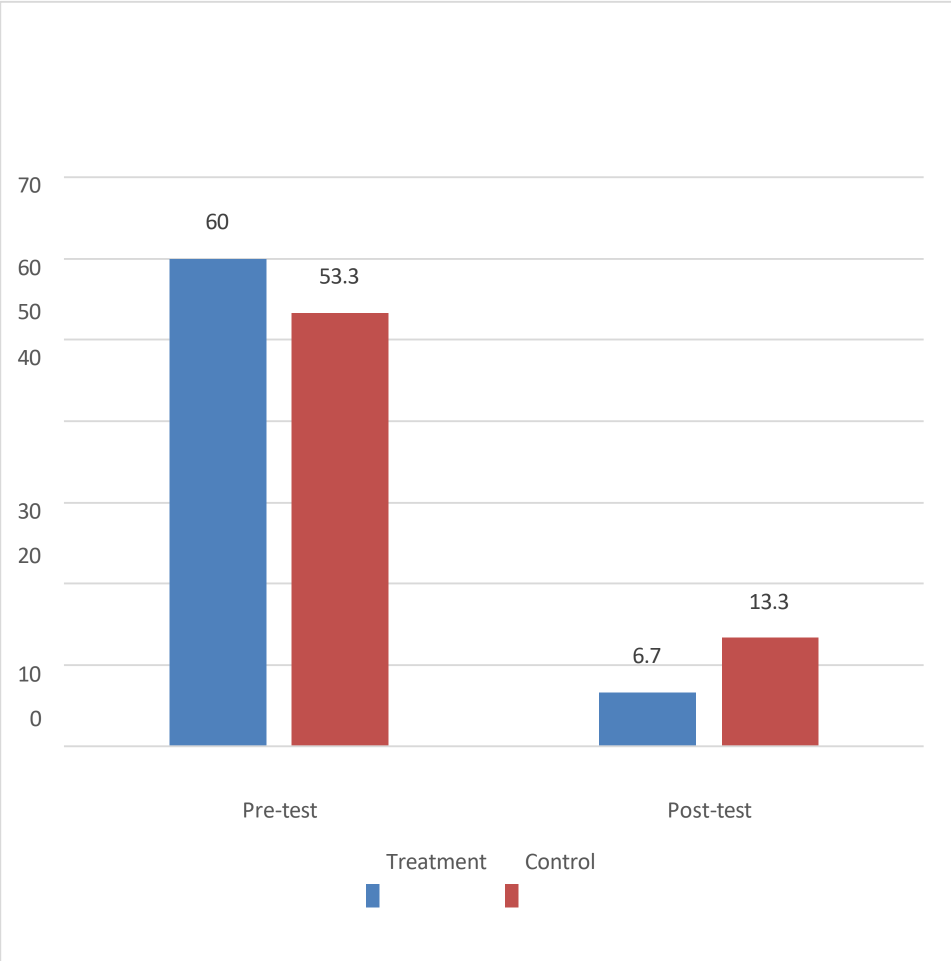

Figure 1: The percentage distribution of anemia in both groups

Figure 1 shows the percentage distribution of anemia prevalence among adolescent girls in the intervention group. At the pretest, 18 participants (60%) were anemic. This condition improved over time, with only 2 participants (6.7%) remaining anemic after one month of iron supplementation accompanied by nutrition education in the local language. In the control group, 16 participants (53.3%) were anemic at the pretest. After one month of iron supplementation alone (positive control), the prevalence of anemia decreased, leaving 4 participants (13.3%) anemic.

The effect analysis result

Table 4: Differences in knowledge scores between the two groups

Knowledge	Pre	Post	Delta	P Value[a]
	Mean±SD	Mean±SD	Mean±SD	
Treatment	5.63±2.22	6.83±1.44	1.20±2.88	0.049
Control	5.30±2.38	6.23±2.26	0.93±3.53	0.097
P Value[b]	0.664	0.250	0.722	

[a]Wilxocon test, [b]Man-Whitney test

Table 4 presents the results of the analysis of knowledge score differences between the two groups. The Wilcoxon test for the intervention group yielded a p-value < 0.05, indicating a significant effect on knowledge improvement after nutrition education delivered in the local language. In contrast, the control group showed a p-value > 0.05, suggesting no significant effect on knowledge in the absence of education. The Mann-Whitney test comparing the mean score changes between the two groups resulted in a p-value of 0.772 (p > 0.05), indicating no statistically significant difference in knowledge improvement between the groups based on the average scores. However, there was a noticeable trend of a higher mean knowledge score improvement in the intervention group compared to the control group.

Table 5: Results of the analysis of hemoglobin level differences between the two groups

Hemoglobin g/dL	Pre-Test	Post-Test	Delta	P-Value[a]
	Mean±SD	Mean±SD	Mean±SD	
Treatment	11.70±1.20	12.45±0.55	0.75±1.10	0.002
Control	12.75±2.06	12.65±1.06	0.10±2.27	0.962
P Value[b]	0.053	0.941	0.061	

[a]Wilxocon test, [b]Man-Whitney test

Table 5 shows the results of the Wilcoxon test analysis of hemoglobin levels in the intervention group, with a p-value < 0.05, indicating a significant effect on hemoglobin levels after the administration of iron supplements accompanied by nutrition education based on the local language. Meanwhile, the control group showed a p-value >0.05, indicating no significant effect on hemoglobin levels after the administration of iron supplements without education. Based on the Mann-Whitney test between the two groups, the change in mean scores yielded a p-value of 0.061 (p > 0.05), indicating no significant difference in hemoglobin levels between the two groups based on the average hemoglobin levels.

Table 6: Results of the analysis of dietary pattern differences between the two groups

Variables	Pre-Test	Post-Test	Delta	P-Value[a]
	Mean±SD	Mean±SD	Mean±SD	
Heme				
Treatment	16.98±2.42	25.24±5.99	8.25±7.16	<0.001
Control	21.83±8.48	27.31±7.85	5.48±12.34	0.041
P-Value[b]	0.002	0.057	0.206**	
Non-Heme				
Treatment	15.55±3.12	18.08±3.24	2.52±3.29	<0.001
Control	16.79±4.25	29.07±0.55	12.28±4.17	<0.001
P-Value[b]	0.425	<0.001	<0.001	

The results of the Wilcoxon test on the intake of iron from Table 4.6, which reports the analysis of differences in iron intake between the two groups, show that the Wilcoxon test for iron intake from heme sources in both groups yielded a p-value < 0.05, indicating a significant difference following nutrition education. The mean intake of iron from heme sources in both groups before the intervention showed a statistical value of p=0.002. After the intervention, there was a meaningful change with a p-value of 0.057, meaning that prior to the education, there was already a difference in the consumption of iron from heme sources, which became statistically insignificant after the education. The difference in the change of heme iron intake between groups was tested using the Mann-Whitney test, resulting in a p-value of 0.206, indicating no significant difference between the two groups. The Wilcoxon test for iron intake from non-heme sources in both groups yielded a p-value < 0.001, indicating a significant difference following nutrition education. The mean intake of iron from non-heme sources in both groups before the intervention showed a statistical value of p=0.452, which then significantly changed to p < 0.001 after the intervention. The difference in the change of non-heme iron intake between groups was tested using the Mann-Whitney test, resulting in a p-value < 0.001, indicating a significant difference between the two groups.

4. DISCUSSION

The majority of respondents in this study were in the age range of 13–15 years (63.3%), which is the period of puberty characterized by increased iron requirements due to body growth and menstruation in adolescent girls. This group dominated both the control group (70.0%) and the intervention group (56.7%). A study by Sari et al. (2020) revealed that adolescents aged 13–15 years are at high risk of anemia due to unbalanced diets and low consumption of iron supplements. Therefore, interventions targeting this age group are relevant to support optimal growth and development during adolescence. Regarding parental occupation, the majority of fathers worked as Civil Servants (36.7%), while most mothers were housewives (63.3%). The father's occupation as a civil servant reflects a stable level of education and income, while the mother, as the household food manager, plays an important role in meeting the family's nutritional needs. Setyaningrum et al. (2021) emphasized that maternal involvement in food management is crucial in preventing anemia, particularly if the mother has knowledge of healthy eating patterns. However, the high prevalence of anemia suggests that parental education and occupation alone are insufficient to meet iron needs.

Most of the respondents' families were in the middle-income category, with a monthly income of IDR 2 million–10 million (68.3%), while 31.7% were in the low-income category. Although the income difference was not statistically significant (p=0.133), low-income families tend to face challenges in meeting nutritious food needs. Utami et al. (2021) found that low income is often correlated with insufficient intake of nutritious food and high prevalence of anemia. Maulida et al. (2020) also showed that economic limitations affect the consumption of heme iron-rich foods, such as red meat and liver. Compliance with iron supplementation was relatively high in both the intervention group (83.3%) and the control group (76.7%), but anemia was still observed. The reduction in anemia was more significant in the intervention group, indicating that iron compliance must be accompanied by a good diet. Anggraini et al. (2019) noted that the effectiveness of iron supplements depends on the intake of other nutrients, such as vitamin C, which enhances iron absorption. Galloway et al. (2014) also observed that barriers, such as the consumption of tea or coffee, can reduce the effectiveness of iron supplements. Local language-based education in this study successfully improved knowledge and compliance, supporting the effectiveness of iron supplementation.

Local language-based nutrition education was proven to be effective in increasing the knowledge of adolescent girls. The Wilcoxon test showed a significant difference in knowledge scores in the intervention group (p=0.049), but not in the control group (p=0.097). Ainsworth et al. (2014) and Sundari et al. (2017) emphasized that culturally and linguistically tailored approaches improve participant understanding. However, the Mann-Whitney test (p=0.772) showed that the difference in average scores between the intervention and control groups was not significant, indicating the importance of considering other factors such as motivation and duration of education. The increase in hemoglobin levels was more significant in the intervention group (p=0.003) compared to the control group (p=0.782). This suggests that the combination of iron supplementation and local language-based nutrition education is effective in increasing hemoglobin levels. Utami et al. (2022) found that education enhances the effectiveness of iron supplements, while Dewi et al. (2023) noted that the use of local language in nutrition counseling reduces communication barriers. However, the Mann-Whitney test (p=0.171) indicated that the difference between groups was not significant, highlighting the importance of community support and the application of knowledge.

Iron intake from heme sources showed a significant increase in the intervention group (p=0.002), but this was not sustained as significant after the intervention (p=0.057). In contrast, non-heme iron intake significantly increased (p<0.001), indicating the effectiveness of local language-based education in improving the consumption of plant-based iron-rich foods. Dewi et al. (2022) and Santoso et al. (2021) noted that nutrition education increases the consumption of plant-based foods and encourages combinations with vitamin C-rich foods to enhance iron absorption. The study found that the intervention group, located in remote areas, faced food access challenges, unlike the control group in more developed areas. Remote communities rely more on natural resources such as venison and fish as sources of heme iron, but prefer to sell them for other needs. Kurniawan et al. (2023) emphasized that culturally and linguistically tailored counseling can lead to sustainable dietary changes, supporting the finding that this approach is effective in improving iron intake. Local language-based nutrition education had a positive impact on improving knowledge, iron intake, and hemoglobin levels in adolescent girls. However, the success of this program requires support from various stakeholders, including local governments, schools, and healthcare providers. This study underscores the importance of culturally tailored approaches combined with improved access to nutritious food and local economic empowerment to address anemia sustainably.

5. CONCLUSION

Local language-based nutrition education significantly improved adolescent girls' knowledge of anemia and iron supplementation compared to iron supplementation alone. Furthermore, this educational approach successfully encouraged dietary changes in the intervention group, particularly by increasing the consumption of non-heme iron sources, which are crucial in meeting their nutritional needs. This approach also demonstrated a positive impact on hemoglobin (Hb) levels, with a significant increase observed in the intervention group. The differences in Hb levels and dietary patterns between the intervention and control groups highlight the importance of local language-based education in enhancing the effectiveness of IFA supplementation programs and reducing anemia prevalence.

Author’s contributions

1. Efrilia Kartini Wambes: Gathered both primary and secondary data from students at Junior High School 1 Jair and Junior High School Ujungkia. Additionally, she performed data analysis using SPSS and Nutrisurvey.
2. Healthy Hidayanty and Nurzakiah: Provided guidance and support throughout all stages of the research, including problem identification, methodological design, and data analysis.
3. Veni Hadju, Abdul Salam, and Shanty Riskiyani: Reviewed the research findings, focusing on methodology, analysis, and conclusions, while offering constructive feedback and suggestions to improve the research quality.

Ethical clearance: This study was approved by the Research Ethics Committee of the Faculty of Public Health, Hasanuddin University, Makassar, with ethical clearance number 1789/UN4.14.1/TP.01.02/2024, dated on July 29, 2024.

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