

Original Research

# The Effectiveness of M-Health Anemia Rematri Application on Knowledge, Attitudes, and Hemoglobin Levels Among Female Adolescents

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## ABSTRACT

**Background:** Anemia among adolescent girls remains a public health problem affecting academic performance, productivity, and future reproductive health. Low levels of knowledge and negative attitudes toward anemia prevention are important risk factors. The use of digital-based educational media, such as the M-Health Anemia Rematri application, is expected to improve the effectiveness of health education. This study aimed to determine the effect of education delivered through the M-Health Anemia Rematri application on knowledge, attitudes, hemoglobin levels, and anemia status among adolescent girls at MA Muslimat NU. **Methods:** This study employed a quasi-experimental design with a one-group pretest–posttest design. The sample consisted of 62 adolescent girls selected using simple random sampling based on the inclusion criteria. The intervention involved educational delivery through the M-Health Anemia Rematri application. Data were collected using questionnaires to assess knowledge and attitudes, as well as measurements of hemoglobin levels and anemia status using a digital Hb device. Data were analyzed using univariate and bivariate methods. Normality was assessed using the Kolmogorov–Smirnov test, while hypothesis testing was conducted using the paired sample t-test, Wilcoxon signed-rank test, and McNemar test. **Results:** This study was conducted on 62 adolescent girls. The statistical analysis showed that the educational intervention using the M-Health Anemia Rematri application had a significant effect on knowledge ( $p = 0.001$ ), attitudes ( $p = 0.001$ ), and hemoglobin levels ( $p = 0.001$ ). **Conclusion:** Education through the M-Health Anemia Rematri application is effective in improving knowledge, attitudes, and hemoglobin levels among adolescent girls. This application has the potential to serve as an innovative and accessible educational medium for anemia prevention.

**Keywords:** Anemia; adolescent girls; M-Health Anemia Rematri application; knowledge; attitudes; hemoglobin levels

## 1. INTRODUCTION

Anemia is a condition characterized by a reduced number of red blood cells or decreased hemoglobin levels in the blood, resulting in a diminished capacity of the blood to transport oxygen to body tissues.<sup>(1)</sup> This condition remains a global public health problem, particularly among women of reproductive age and adolescents. According to the World Health Organization (WHO), approximately 30% of women aged 15–49 years worldwide suffer from anemia.<sup>(2)</sup> Adolescent girls have a higher risk compared to boys due to menstruation and increased iron requirements during

growth.<sup>(3)</sup> Anemia in adolescents can lead to decreased concentration, reduced academic performance, lowered immunity, and may potentially cause reproductive health problems in the future.<sup>(4)</sup>

In Indonesia, anemia among adolescents remains a significant issue that requires serious attention. Data from the Basic Health Research (Riskesdas) in 2018 showed that the prevalence of anemia among individuals aged 15–24 years reached 32%.<sup>(5)</sup> Although the Indonesian Health Survey (SKI) in 2023 reported a decline to 15.5%, this figure still indicates that anemia remains a significant health problem.<sup>(6)</sup> In Central Kalimantan Province, the coverage of iron supplementation (*Tablet Tambah Darah/TTD*) among adolescent girls increased from 26.5% in 2018 to 48.6% in 2023.<sup>(6)</sup> However, local data indicate that the prevalence of anemia remains relatively high, such as in Palangka Raya City, where it was reported at 49.82%.<sup>(7)</sup> Furthermore, data from the Panarung Primary Health Center showed that out of 72 adolescent girls examined, 47.22% were found to be anemic, indicating the need for more effective interventions at the local level.

The occurrence of anemia among adolescent girls is influenced by various factors, including inadequate iron intake, unbalanced dietary patterns and adherence to iron supplementation, as well as knowledge and attitudes toward anemia prevention. Limited knowledge and suboptimal attitudes toward anemia are still commonly found among adolescent girls, which contribute to poor preventive behaviors.<sup>(8,9)</sup> This condition leads to a lack of understanding regarding the importance of iron intake, compliance with iron supplementation, and maintaining a healthy lifestyle to prevent anemia.<sup>(10)</sup> Therefore, health education is an important strategy to improve knowledge and foster positive attitudes toward anemia prevention.

With the advancement of technology, health education methods have evolved by utilizing digital media such as mobile health (m-health) applications, which are considered more interactive and accessible.<sup>(11)</sup> The M-Health Anemia Rematri application is an Android-based educational innovation developed by lecturers from the Midwifery Department of Poltekkes Kemenkes Palangka Raya, namely Seri Wahyuni, SST., M.Kes and Greiny Arisani, SST., M.Kes, in 2024. This application is specifically designed to improve knowledge and awareness of adolescent girls regarding anemia through various educational features, including anemia education materials, information on iron supplementation (TTD), anemia symptom screening, a Body Mass Index (BMI) calculator, video and booklet

media, myths and facts about anemia, interactive quizzes, and a counseling corner.

The M-Health Anemia Rematri application has also undergone feasibility testing by media experts, content experts, and users, with results indicating a high level of feasibility (>90%), thus confirming its suitability as a health education tool. The use of m-health applications has great potential to improve knowledge and health behavior due to their flexibility and ease of access.<sup>(12)</sup> However, the effectiveness of this application in improving knowledge, attitudes, as well as its impact on hemoglobin levels and anemia status still requires further investigation. Therefore, this study aims to analyze the effect of education delivered through the M-Health Anemia Rematri application on knowledge, attitudes, hemoglobin levels, and anemia status among adolescent girls at MA Muslimat NU Palangka Raya (Muslimat NU Islamic Senior High School of Palangkaraya City).

## 2. METHODS

### 2.1 Research Design

This study used a quantitative approach using a pre-experimental design with a one-group pretest–posttest design. In this research design, initial measurements were conducted through a pretest, followed by the administration of an intervention using the M-Health Anemia Rematri application. A posttest followed to assess changes before and after the intervention.

### 2.2 Research Setting and Time

The study was conducted at MA Muslimat NU Palangka Raya (Muslimat NU Islamic Senior High School of Palangkaraya City). The research was carried out from November to December 2025, with the intervention administered four times to assess improvements in knowledge, attitudes, hemoglobin levels, and anemia status among adolescent girls.

### 2.3 Population and Sample

The population in this study consisted of 129 adolescent girls in grades 10, 11, and 12 at MA Muslimat NU. The sample size was calculated using the Slovin formula, resulting in a required sample of 56 respondents. An additional 10% was added to account for potential dropouts, bringing the total sample size to 62 adolescent girls at MA Muslimat NU.

### **2.4 Sampling Technique and Inclusion-Exclusion Criteria**

Sampling was done using probability sampling, where every member of the population had an equal chance of being selected. The method was simple random sampling, with samples chosen randomly without regard to population strata. The selection process involved a lottery, based on students' attendance lists, and adhered to inclusion and exclusion criteria. The inclusion criteria in this study were adolescent girls who used Android-based smartphones, participated in all stages of the study, including hemoglobin level measurement, pre-test, health education intervention, and post-test, and were not menstruating at the time of hemoglobin examination. Exclusion criteria were girls who didn't complete the questionnaire.

### **2.5 Variables**

Independent variable: Education delivered through the M-Health Anemia Rematri application. Dependent variable: Knowledge of adolescent girls toward anemia prevention, Attitudes of adolescent girls toward anemia prevention, hemoglobin levels, and anemia status.

### **2.6 Types of Data and Data Collection Techniques**

The data obtained to fulfill the research objectives consisted of primary and secondary data. Primary data were collected directly from respondents using research instruments. Secondary data also included information about the research location and the number of adolescent girls in grades 10, 11, and 12 at MA Muslimat NU Palangka Raya. Data collection involved measuring hemoglobin levels and determining anemia status. A pretest assessed knowledge and attitudes toward anemia prevention. This was followed by the intervention, which involved providing education through the M-Health Anemia Rematri application. Finally, hemoglobin levels were re-measured to determine anemia status after the intervention, and a posttest was administered to evaluate whether there were improvements in knowledge and attitudes toward anemia prevention among adolescent girls.

### **2.7 Data Collection Instruments**

In this study, researchers used a digital hemoglobin measurement device and questionnaires to assess adolescent girls' knowledge and attitudes about anemia prevention. Hemoglobin levels and anemia status were measured with a digital hemoglobin testing device.

The knowledge and attitude questionnaires were adapted from instruments that had been previously tested for validity and reliability. The knowledge section consisted of 20 questions covering concepts of anemia, methods of anemia prevention, and dietary sources to prevent anemia. The attitude section included both questions and statements measured using a Likert scale, consisting of favorable (positive) and unfavorable (negative) items.

### **2.8 Statistical Analysis**

Data analysis in this study was performed using IBM SPSS Statistics version 27. The analyses included univariate and bivariate analysis. Univariate analysis found mean knowledge, attitude, and hemoglobin levels, and identified anemia status in adolescent girls before and after the intervention using the M-Health Anemia Rematri app. Bivariate analysis examined the M-Health Anemia Rematri app's effect on knowledge, attitudes, hemoglobin levels, and anemia status in adolescent girls at MA Muslimat NU before and after the intervention. In the bivariate analysis, normality tests and hypothesis testing were performed. Normality was checked with the Kolmogorov-Smirnov test: data were normal if the significance value was  $>0.05$ , not normal if  $<0.05$ . Based on the normality test, hypothesis testing was done with suitable statistical tests. The knowledge and attitude variables were analyzed using the Wilcoxon Signed-Rank Test. Hemoglobin levels were analyzed with the Paired Sample t-test. Anemia status was analyzed with the McNemar test.

## **3. RESULTS**

Based on the results of the study conducted among 62 adolescent girls, Table 1 shows an increase in the mean values of all variables related to anemia prevention before and after the educational intervention. The mean increase in knowledge after the intervention was 13.23, while the mean increase in attitude was 8.98. This indicates that education using the M-Health Anemia Rematri application was able to improve the knowledge and attitudes of adolescent girls toward anemia prevention. The mean hemoglobin level increased by 0.12 g/dL. Although the increase was relatively small, this result indicates an improvement in hemoglobin levels following the educational intervention.

Based on Table 2, among the 62 respondents, before receiving education through the M-Health Anemia Rematri application, 38 individuals (61.3%) were not

anemia and 24 (38.7%) were anemia. After the intervention, the number of non-anemia respondents increased to 42 (67.7%), while those with anemia decreased to 20 (32.2%). Descriptively, these findings

indicate an increase in the proportion of non-anemia adolescent girls and a decrease in those with anemia; however, further bivariate analysis is required to determine the statistical significance of these changes.

**Table 1.** Mean knowledge, attitudes, and hemoglobin levels of adolescent girls regarding anemia prevention at MA Muslimat NU before and after education

Variable	Pre-Post Test	Mean	SD	Minimum	Maximum	Mean increase
Knowledge	Pre-test	75.24	9.77	55	90	13.23
	Post-test	88.47	8.85	70	100	
Attitude	Pre-test	58.63	6.89	44	71	8.98
	Post-test	67.61	6.41	53	75	
Hemoglobin Levels	Pre-test	12.76	1.62	9.1	16.2	0.12
	Post-test	12.88	1.60	9.4	16.4	

**Table 2.** Anemia status in adolescent girls before and after education using app M-Health Anemia Rematri

Anemia status adolescent girls	Before education		After education	
	n	%	n	%
Not Anemia	38	61.3%	42	67.7%
Anemia	24	38.7%	20	32.3%
Total	62	100%	62	100%

Bivariate analysis was conducted to determine the effect of education using the M-Health Anemia Rematri application on knowledge, attitudes, hemoglobin levels, and anemia status before and after the intervention, preceded by a normality test to ensure the assumptions of hypothesis testing were met. Based on Table 3, the normality test showed that the knowledge and attitude variables in the pretest and posttest were not normally distributed ( $p < 0.05$ ), while hemoglobin levels were normally distributed ( $p > 0.05$ ). Knowledge and attitude were analyzed using the Wilcoxon Signed-Rank Test, hemoglobin levels using the Paired Sample t-test, and anemia status using the McNemar test, which is suited for paired categorical data.

**Table 3.** Normality test

Variable	Sig.	Description
<b>Knowledge</b>		
Pretest	0.001	Not normally distributed
Posttest	0.006	Not normally distributed
<b>Attitude</b>		
Pretest	0.034	Not normally distributed
Posttest	0.018	Not normally distributed
<b>Hemoglobin Levels</b>		
Pretest	0.200	Normally distributed
Posttest	0.200	Normally distributed

Based on the analysis in Table 4, hypothesis testing revealed significant values for knowledge ( $p = 0.001$ ), attitudes ( $p = 0.001$ ), and hemoglobin levels ( $p = 0.001$ ). The results indicate significant differences before and after the educational intervention using the M-Health Anemia Rematri application. Therefore, it can be concluded that the application-based education had a significant effect on improving knowledge, attitudes, and hemoglobin levels among adolescent girls at MA Muslimat NU. However, the analysis of anemia status showed a  $p$ -value of 0.125 ( $p > 0.05$ ), indicating no

**Table 4.** The effect of the M-Health Anemia Rematri application on knowledge, attitudes, hemoglobin levels, and anemia status among adolescent girls at MA Muslimat NU before and after education

Variable	Statistical test	Sig.	Description
Knowledge	Wilcoxon test	0.001	Significant effect
Attitude	Wilcoxon test	0.001	Significant effect
Hemoglobin levels	Paired sample t-test	0.001	Significant effect
Anemia status	McNemar test	0.125	No significant effect

statistically significant change in anemia status before and after the intervention. Despite a decrease in the number of adolescent girls with anemia, the change was not strong enough to demonstrate a significant effect on anemia status.

#### 4. DISCUSSION

Based on the results of the study conducted among 62 adolescent girls at MA Muslimat NU Palangka Raya, it was found that the mean knowledge score before receiving education using the M-Health Anemia Rematri application was 75.24 and increased to 88.47 after the intervention, with a difference of 13.23. The Wilcoxon test showed a  $p$ -value of 0.001 ( $p < 0.05$ ), indicating a significant effect of the educational intervention on improving adolescent girls' knowledge in anemia prevention.

These findings are consistent with the study by Muliana, which reported an increase in knowledge through an Android-based application with a  $p$ -value of 0.001, as well as the study by Luthfiya, which also found a significant improvement in adolescents' knowledge after application-based education with a  $p$ -value of 0.028. This suggests that digital application-based media have consistent effectiveness in improving adolescents' knowledge regarding anemia.<sup>(13,14)</sup>

This effectiveness is supported by the advantages of application-based educational media, which can present information interactively through a combination of text, images, audio, and animations, making it more engaging and easier to understand. The M-Health Anemia Rematri application also provides ease of access and encourages active user engagement in the learning process. Through stimulation of visual and auditory senses, information can be received more effectively, thereby enhancing adolescents' understanding.<sup>(13)</sup> In addition, the direct involvement of respondents in using the application enables an active learning process that supports the improvement of knowledge and the development of better attitudes.<sup>(15)</sup> Therefore, education using the M-Health Anemia Rematri application has proven to be an effective medium for improving adolescent girls' knowledge of anemia prevention.

In line with the improvement in knowledge, the results of this study also show that education delivered through the M-Health Anemia Rematri application had a significant effect on improving adolescent girls' attitudes. The mean attitude score increased from 58.63 before the

intervention to 67.61 after education, with a difference of 8.98. The Wilcoxon Signed Rank Test yielded a  $p$ -value of 0.001 ( $p < 0.05$ ), signifying a statistically significant alteration in attitudes post-intervention.

These findings are consistent with the study by Saraswati, which reported an improvement in attitudes with a  $p$ -value of 0.001 after using the Aneminfo application, as well as the study by Nomiaji, which also found a significant effect of education through social media on adolescent girls' attitudes toward anemia ( $p < 0.05$ ). This suggests that digital-based educational media are effective in shaping changes in adolescents' attitudes.<sup>(16,17)</sup>

The observed changes in attitude indicate that education not only improves cognitive aspects but also influences the affective domain of adolescent girls. Increased knowledge can shape better perceptions and beliefs, thereby encouraging the development of positive attitudes toward anemia prevention. Attitudes are dynamic and can change when supported by appropriate information and engaging media.<sup>(4)</sup> Interactive educational media, such as m-health applications, have demonstrated their ability to enhance adolescent engagement, thereby strengthening attitude changes.<sup>(18)</sup> These positive attitudes have the potential to promote better health behaviors, such as increased consumption of nutritious foods and adherence to anemia prevention practices, which can ultimately contribute to improved health status among adolescent girls.

The results showed that the mean hemoglobin level of adolescent girls increased from 12.76 g/dL before the intervention to 12.88 g/dL after receiving education using the M-Health Anemia Rematri application, with a mean difference of 0.12 g/dL. The paired sample  $t$ -test results indicated a  $p$ -value of 0.001 ( $p < 0.05$ ), meaning that there was a significant effect of education using the M-Health Anemia Rematri application on changes in hemoglobin levels.

These findings are consistent with the study by Lusita which showed an increase in the average hemoglobin level from 11.6 g/dL before education using video media to 12.3 g/dL after the intervention. In addition, the study by Anwar reported that the average hemoglobin level before consuming iron tablets with the use of the Ceria application was 9.94 g/dL and increased to 12.89 g/dL after the intervention, with a statistical test result of  $p$ -value 0.000, indicating a significant effect. Furthermore, the study by Yolanda also demonstrated an increase in hemoglobin levels from 12.97 g/dL to 13.18

g/dL after intervention using the EDUANEMIA application, with an increase of 0.21 g/dL. These findings indicate that the use of health education applications has the potential to improve hemoglobin levels among adolescent girls.<sup>(19-21)</sup>

This study was conducted on the same respondents for hemoglobin measurements before and after the educational intervention. Although the increase in hemoglobin levels was relatively small, at 0.12 g/dL, the results still indicate a physiological improvement. Education through the M-Health Anemia Rematri application is assumed to enhance adolescents' awareness of the importance of adequate nutritional intake and anemia prevention, which may indirectly influence hemoglobin levels. These findings are also in line with previous studies stating that health education can have an impact on hemoglobin levels, although the changes are generally not substantial in a short period. Several studies suggest that improving hemoglobin levels requires a longer duration and additional interventions, such as iron supplementation and dietary improvements, to achieve more optimal outcomes.<sup>(22,23)</sup>

Furthermore, based on the results of the study conducted on 62 adolescent girls at MA Muslimat NU, it was found that before the educational intervention, 24 respondents (38.7%) experienced anemia, which decreased to 20 respondents (32.3%) after the intervention. Descriptively, this indicates a reduction in the number of adolescent girls experiencing anemia after receiving education through the M-Health Anemia Rematri application. However, the results of the McNemar test showed a p-value of 0.125 ( $p > 0.05$ ), indicating that the change in anemia status was not statistically significant.

These findings differ from the study by Anwar which reported a significant improvement in anemia status after an intervention involving iron (Fe) tablet consumption supported by an application, where most respondents were no longer anemia.<sup>(20)</sup> This difference suggests that interventions combined with direct iron supplementation have a greater impact on improving anemia status compared to education alone. The lack of significant change in anemia status in this study may be attributed to the relatively short duration of the intervention. Health education tends to improve knowledge and attitudes more rapidly, whereas changes in health status, including anemia, require a longer duration and are influenced by additional factors such as adherence to iron tablet consumption, dietary patterns,

and the physiological condition of adolescents. Therefore, more comprehensive and sustained interventions are needed to achieve significant improvements in anemia status.<sup>(10,24,25)</sup>

This study has limitations because it used a pre-experimental design without a control group. Therefore, changes in knowledge, attitudes, hemoglobin levels, and anemia status in the experimental group cannot be compared with those in the group that did not receive the intervention. The application used in this study does not yet have a discussion feature or direct communication channel between the developers and users. This serves as a recommendation for future research aimed to improving the M-Health Anemia Rematri application.

## 5. CONCLUSION

Based on the results of the study, education delivered through the M-Health Anemia Rematri application was found to have a significant effect on improving knowledge ( $p = 0.001$ ), attitudes ( $p = 0.001$ ), and hemoglobin levels ( $p = 0.001$ ) among adolescent girls at MA Muslimat NU. This indicates that the use of digital-based educational media is effective in enhancing understanding and fostering positive attitudes among adolescents in anemia prevention efforts. In addition, the M-Health Anemia Rematri application demonstrates strong potential as an innovative, accessible, and engaging health education medium for adolescents. The use of this application supports independent learning processes and increases adolescents' engagement in understanding information related to anemia and its prevention. However, the intervention did not show a statistically significant effect on anemia status ( $p = 0.125$ ), although an improving trend was observed. This suggests that changes in anemia status require a longer period of time and are influenced by various other factors, indicating the need for more comprehensive and sustained interventions to achieve optimal outcomes.

### Ethical Approval

The study received ethical approval from the Health Research Ethics Commission of Poltekkes Kemenkes Palangka Raya with letter number: No.33/1/KE.PE/EXM/2026.

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## Competing Interests

All the authors declare that there are no conflicts of interest.

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## Underlying Data

Derived data supporting the findings of this study are available from the corresponding author on request.

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