

Online Health Promotion about Anemia Towards Adolescent Females and It's Effectiveness

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ABSTRACT

Background: Anemia poses greater risk in females, contributing to stunting. Despite reliance on online platforms, limited research investigated their impact on adolescents' knowledge, attitudes, and practices toward anemia prevention. This study aimed to evaluate the effectiveness of online health promotion towards the knowledge, attitude, and practices of adolescent females in preventing anemia.

Methods: This experimental study employed a pretest-posttest control group design. The intervention group received an online health promotion and module, while the control group received a leaflet. The sample was 100 female students from two senior high schools, selected through proportional stratified random sampling. The instrument used questionnaires validated by all items have r count $>$ r table (0.195), and a reliability test using Cronbach's Alpha obtained $>$ 0.7, showing reliable instrument. The analysis utilized a non-parametric test Wilcoxon test, to understand the effectiveness with effect size, and the Mann-Whitney test to compare differences between groups.

Results: Statistical tests revealed significant effectiveness and differences ($p < 0.05$), within the large effect size of 0.92–0.96. The magnitude was evident in intervention group; 90% respondents showed good knowledge, 92% positive attitudes and practices, compared to the control group, showed 64% attitudes, 62% practices, and 62% knowledge. The results imply that online health education with module-based health is effective in empowering adolescents about anemia.

Conclusion: The findings underscore the effectiveness of online health promotion. Schools can adopt this approach as policy to promote sustainable and healthy practices for anemia prevention. Further research should provide refinement, involve larger and more diverse population with socioeconomic analysis.



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INTRODUCTION

Anemia is a condition of a person having hemoglobin (Hb) levels lower than 12.0 and 13.0 g/dL in females or males. Adolescent females are one of the groups prone to anemia and are at higher risk than males because they experience menstrual cycles every month, limited dietary iron intake, and faulty dietary habits. One way to overcome anemia is to increase the consumption of foods that contain high levels of iron (Anitha et al., 2021). Living in urban areas, adolescent

females are accessible to instant food, which contains low iron levels. Limited knowledge of nutrition and health in adolescents, especially those related to anemia, causes them to adopt detrimental eating habits that impact their health (Mustafa, -Sutjiati, & Agustin, 2023; Sari, Judistiani, Hilmanto, Herawati, & Dhamayanti, 2022). Besides, the habit of excess nutrients or being overweight also contributes to the health problem of anemia, as being overweight can disrupt iron homeostasis, resulting in iron deficiency anemia (Alshwaiyat, Ahmad, Wan Hassan, & Al-jamal, 2021; Damayanti, Fathimah, Sari, & Pibriyanti, 2023).

Some researchers have analyzed the online health promotion impacts on adolescents. Research on health education for adolescent females in preventing anemia has been conducted using by using Zoom meetings. It proves that it affects the knowledge difference before and after the treatment by online health promotion. The knowledge was gained from the information delivered in the online meeting by Lestari, Dwi Lestari, & Santoso, 2021). It was conducted with a total of 36 respondents. The findings show a significant increase in mean knowledge score ($p < 0.05$), but the Mann-Whitney test didn't find a significant difference between groups. However, this study has a very small sample size, which limits statistical power and generalisability. Greater samples offer greater statistical power. Besides, it only analyzes knowledge; meanwhile, broader outcomes such as attitudes and practices (practicesal changes) matter, which show valuable advancement after knowledge. Other researchers have also analyzed the impact of online learning on knowledge and practices (Zhu et al., 2022). This study analyzed the environment in learning activities, resulting in teaching ability having the strongest impact (0.59), platform support (0.40), and knowledge system having a weak impact 0.13. It highlights that online learning platforms can improve learning ability even in low-impact settings. However, this study measured only learning in general rather than health-practices or specific content such as anemia prevention. It means that this study doesn't directly measure health outcomes or non-interventional research. Whereas, including the module in online learning may provide a valuable methodological choice. Research by Tang et al. (2023) analyzed the online learning during the COVID-19 pandemic in. It focuses on psychosocial variables i.e., knowledge, with 179 first-year students of the university. The results indicate that online learning doesn't greatly impact knowledge acquisition due to a lack of sense of belonging shifted by the COVID-19 pandemic. This is confirmed by (Yuzulia, 2021) that the difficulty lies on understanding materials with limited interaction. Therefore, besides online education, a module can also be provided to create a student's sense of belonging in terms of how the respondents can connect with the learning environment and feel the importance of the learning.

This study addresses a critical gap in adolescent health promotion research on anemia prevention, as most previous studies focused on university students rather than high-school girls who are at higher physiological risk. Using an experimental design with a control group, this study applies online health promotion combined with module-based learning, offering greater flexibility, accessibility, and alignment with adolescents' digital habits compared to traditional methods (Zamiri & Esmaeili, 2024). This approach provides a novel contribution by targeting a vulnerable population and evaluating integrated outcomes of knowledge, attitudes, and practices, supported by stronger evidence through the inclusion of a control group.

Therefore, this study aims to analyze the association of online health promotion to prevent anemia, accompanied by a module on the variables of knowledge, attitude, and practices among female adolescents in senior high schools.

METHODS

This research employs an experimental design with control and intervention groups involving students from SMA N 1 Rendang and SMA N 5 Denpasar, Bali. The research has obtained ethical approval with Ethical Clearance No. LB.02.03/EA/KEPK/0271/2022.

Determining the sample size in this study was carried out using the Dahlan formula (Mushlih & Rosyidah, 2020).

$$n_1 = n_2 = 2 \left[\frac{Z_\alpha + Z_\beta}{x_1 - x_2} \right] \quad \text{Eq. 1}$$

In this calculation, the type I error was determined to be 1% ($Z\alpha = 2.81$) with a two-way hypothesis, and the type II error was 5% ($Z\beta = 1.64$). The minimum mean difference that is considered meaningful ($x_1 - x_2$) is 5.2 points ($49.03 - 43.59 = 5.44$ rounded to 5). While the combined standard deviation is (Mushlih & Rosyidah, 2020):

$$S = \sqrt{\frac{S_1^2(n_1-1) + S_2^2(n_2-1)}{n_1 + n_2 - 2}} \quad \text{Eq. 2}$$

The standard deviation value obtained was 5.03, which was rounded up to 5, so when calculating the sample size, we got a sample of 44.5, which was rounded up to 45 people for each group/school. To cover the possibility of dropping out so that other respondents are not substituted, the minimum number of respondents can be increased by 10% of the minimum number of respondents. In conclusion, the number of respondents who will be studied is 50 respondents at SMA Negeri 1 Rendang (intervention group) and 50 respondents at SMA Negeri 5 Denpasar (control group).

The data collection instrument was in the form of a questionnaire composed of questions with possible answers, right or wrong. Right is scored 1, and Wrong is scored 0. The categorization included Good, Fair, and Bad. The cut-off points of percentage in knowledge are at Good if the score is 76-100%, Fair if the score is 56-75% and Poor if the score at <56% (Sugiyono, 2017). The attitude data is collected using a statement sheet with two possible answers, namely Positive or Negative attitude. Meanwhile, the practices data uses answer sheets about the respondent's practices in carrying out the prevention of anemia: Done or Not. Meanwhile, for the attitudes, the positive value is at 80-100% and the negative value is at < 80%, and for practices, it also follows the same categorization for Done or Not (Al-Hanawi et al., 2020).

In terms of recruitment, a sampling frame was obtained from the student enrollment lists provided by SMA N 1 Rendang and SMA N 5 Denpasar. The inclusion criteria for participants were age, possession of a smartphone, and willingness to be respondents. Exclusion criteria were applied to adolescent females with specific food allergies. The researchers identified eligible participants based on these criteria. This study used proportional stratified random sampling to select the participants, in which each grade (X, XI, and XII) formed a stratum; then, lists were numbered and random numbers were used to select students from each stratum until the required sample per school was reached, with 50 respondents per school. For allocation, schools functioned as clusters, with SMA N 1 Rendang as the intervention group using online health promotion and a module. and SMA N 5 Denpasar was assigned as the control group using a leaflet only. The allocation of clusters was chosen a priori for logistical reasons to reduce the risk of contamination between groups if the intervention and control groups were mixed from the same school. The enumerators in the research administered baseline and follow-up questionnaires in Google Forms. Enumerators were trained to follow identical procedures to reduce measurement bias.

The study used primary data collected directly from respondents. The research was conducted over two weeks, including a preparation phase on Days 1–6 involving participant recruitment, informed consent, pre-test administration, and group assignment. Eligible respondents were personally contacted, informed about the study procedures, and included in a WhatsApp group to support communication, motivation, and reminders. Educational materials (modules, leaflets, and pre–post-test questionnaires) were prepared using Google Forms. On Day 7, the intervention group received online health education via Zoom, accompanied by modules and leaflets, while the control group received leaflets only. The module covered anemia prevention, causes, signs and consequences, dietary prevention, supplementation and health services, and practical skills. A post-test using the same questionnaire was administered seven days after the intervention.

Data normality was assessed using the Shapiro–Wilk test, which indicated that knowledge, attitude, and practice scores were not normally distributed ($p < 0.05$). Therefore, non-parametric

tests were applied. The Wilcoxon signed-rank test was used to compare pre- and post-test scores within each group, while the Mann–Whitney U test was used to compare outcomes between the intervention and control groups, as these tests are suitable for non-normally distributed data.

In terms of dropout management and missing data handling, this study defined completion as the provision of the outcome questionnaire at the post-test. To minimize attrition, multiple retention strategies were conducted, such as advance scheduling, reminder messages, and follow-up calls. Reasons for non-participation and dropout were recorded, and the primary analysis followed an intention-to-treat approach, assigning participants to the groups. Missing responses were checked systematically that if fewer than 20% items within a scale were missing, the mean of completed items was used, and cases with greater missingness were excluded from the particular analysis. Sensitivity analyses using complete-case and per-protocol approaches were performed to ensure the robustness of results.

Socioeconomic status was not assessed in this study because all the participants were recruited from public senior high schools within comparable community settings, reducing the likelihood of major socioeconomic differences. The focus of this research was to evaluate the impact of an online health education intervention rather than socioeconomic determinants.

Selection bias was reduced by using proportional stratified random sampling to select participants from two comparable schools, i.e., from public senior high schools. Random allocation of classes into control and intervention groups ensured group comparability. To prevent contamination bias, both groups were taught and assessed separately, and participants were instructed not to exchange learning materials during the intervention period. All data were collected using the same validated instrument and administered by trained personnel to maintain consistency.

An analysis of effect size based on the Wilcoxon test was also conducted following Equation 3.

$$r = \frac{z}{\sqrt{N}} \quad \text{Eq. 3}$$

Where r is the effect size, Z is the Z-score, and N is the number of respondents in each group. The effect size is classified as a trivial effect (<0.1), small effect ($0.1 - 0.3$), moderate effect ($0.3 - 0.5$), and large effect (>0.5) (Brydges, 2019).

The questionnaires for knowledge, attitudes, and practices have 10 questions each. The knowledge items assessed respondents' understanding of the causes, signs and symptoms, risk factors, and prevention of anemia. The attitude items explored respondents' perceptions, awareness, and beliefs regarding anemia prevention, iron intake, and the importance of health education. Meanwhile, the behavior items described daily practices associated with anemia prevention, including dietary habits, iron tablet consumption, and other health-related behaviors. Validity and reliability tests were performed to confirm that the questionnaires are valid and reliable. All the questionnaire items in knowledge, attitude, and practices were tested for their validity and reliability. All questionnaire items are declared valid, because the calculated r value of each item is greater than the table r (0.195), as the respondents were 100. In the knowledge aspect, the calculated r value ranges from 0.603–0.732. In the attitude and practices aspects, all items have a calculated r value above the critical value with a range of 0.547–0.741 for attitude, and 0.537–0.687 for practices. Thus, all questions are considered valid for measuring the intended construct consistently and are suitable for use in research data collection. Cronbach's Alpha coefficients for all variables are above 0.7, i.e. 0.831 for knowledge, 0.875 for attitude and 0.782 for practices, indicating that the questionnaire is reliable and consistent for data collection among adolescent girls. Therefore, the validity and reliability tests result that the instrument can be used for the study.

RESULTS

The results highlight significant differences in knowledge, attitudes, and practices between the intervention and control groups following the educational intervention. Effect size was also

presented to measure the effect of the intervention.

Table 1. Changes in Variables Before and After Online Health Promotion

Variables	Category	Intervention (Pre) n (%)	Control (Pre) n (%)	Intervention (Post) n (%)	Control (Post) n (%)
Attitude	Fair	43 (86.0)	43 (86.0)	5 (10.0)	18 (36.0)
	Good	3 (6.0)	3 (6.0)	45 (90.0)	31 (62.0)
	Negative	50 (100)	50 (100)	4 (8.0)	18 (36.0)
	Positive	0 (0)	0 (0)	46 (92.0)	32 (64.0)
Practices	Not Performed	50 (100)	50 (100)	4 (8.0)	19 (38.0)
	Performed	0 (0)	0 (0)	46 (92.0)	31 (62.0)

Table 1 shows a clear upward trend in the intervention group in all categories after the intervention was performed. After the intervention, 90% of respondents in the intervention group demonstrated good knowledge, 92% showed positive attitudes, and 92% performed preventive practices. In contrast, the control group had lower improvement rates, where knowledge at 62%, attitude at 64%, and practice at 62%. The most highlighted increment occurred in the “good” knowledge category, rising from only a small proportion before the intervention to nearly all participants afterward. Similarly, positive attitudes and preventive practices toward anemia improved substantially, indicating that the intervention successfully influenced both cognitive and practical domains. Besides, the control group also shows some improvement after receiving the leaflet; however, the magnitude of change is considerably smaller. This is due to the leaflet, as the traditional method may be less effective in encouraging practices.

Table 2. Effectiveness of Online Health Promotion

Variables	Group	Wilcoxon Test		Mann Whitney		Interpretation
		Z-value	p-value	Mean Rank	p-value	
Knowledge	Intervention	-6.500	0.000	57.70	0.002	Significant improvement
	Control	-5.231	0.000	43.30		Moderate improvement
Attitude	Intervention	-6.782	0.000	57.50	0.001	Significant improvement
	Control	-5.657	0.000	43.50		Moderate improvement
Practice	Intervention	-6.782	0.000	58.00	0.000	Significant improvement
	Control	-5.568	0.000	43.00		Moderate improvement

Table 2 shows that there are significant differences ($p < 0.05$) in all three variables, indicating that online health promotion effectively improved knowledge, attitude, and practice among adolescent females. A higher mean rank is also obtained in the intervention group, which highlights the greater efficacy of online health promotion and module-based education.

Table 3. Effect Size in Variables

Variables	Group	Effect size (r)	Interpretation
Knowledge	Intervention	0.92	Large effect
	Control	0.74	Large effect, but smaller than the intervention
Attitude	Intervention	0.96	Large effect
	Control	0.80	Large effect, but smaller than the intervention

Variables	Group	Effect size (r)	Interpretation
Practices	Intervention	0.96	Large effect
	Control	0.79	Large effect, but smaller than the intervention

Table 3 indicates that all the variables resulted in a large effect, particularly for the intervention group, which has 0.92 – 0.96 effect size, compared to the control group, which has smaller values of effect size. This reflects that the intervention of online health promotion brings a large effect towards the improvement of knowledge, attitude, and practices.

DISCUSSION

The present study demonstrated that the use of a health education module significantly improved the knowledge, attitude, and practices of adolescent females regarding anemia prevention. This finding supports previous studies by (Riesmiyatiningdyah, Putra, & Sulistyowati, 2021), which also reported positive effects of educational modules on anemia-related knowledge (p-value 0.011), with the reliable knowledge level questionnaire with Cronbach's Alpha 0.594, with 24 respondents. Besides, it is also in line with (Yulianingsih, Yanti, & Hulawa, 2023) that the educational printed media, such as a booklet, can increase the knowledge with a p-value of 0.000. The association of education on anemia among adolescent females has proven to increase the knowledge of the teaching from health cadres. However, knowledge, attitude, and practices are inseparable as the embodiment of health promotion objectives (Sinaga, 2022). The improvement observed in this study suggests that using structured and participatory learning materials can effectively enhance awareness and promote preventive actions among adolescents. Even this study has a larger sample size with 100 respondents, which is more reliable and generalizable with broader variables using attitude and practices.

Nevertheless, not all the studies provided consistent results. Research shows that the educational program of anemia prevention for girls aged 14-19 years old in Iran resulted in a p-value of 0.213 for attitude and practices p-value of 0.547, showing no significant differences (Rakhshani et al., 2025). Anemia prevention is a pivotal thing in adolescence. Regarding the sample of urban adolescent females, research stated that the dominant determinant of anemia is menstrual status (Ekasanti, Adi, Yono, Nirmala, & Isfandiari, 2020). Therefore, education about anemia is important to conduct to reduce the prevalence of anemia among adolescent females. However, to shape a practisesal change, it requires cognitive awareness, which also depends on motivation, family support, socioeconomic condition, and access to health resources. The differences highlight to adapt health educational strategies to the target population despite different study designs, and facilitators may also vary the findings.

In this study, there is an increase in the attitude of the respondents. The tendency to respond positively and negatively to certain objects or situations remains in the attitude. Attitudes contain emotional judgments (affective component), knowledge about an object (cognitive component), and tendencies to act (conative component). Besides, it can change by obtaining additional information about certain objects. Attitude change is related to the change of certain formed attitudes upon receiving the information or under the influence (Zhang, Wu, & Liu, 2021). Providing education related to anemia is by the intervention given to the intervention group, which impacts the attitude. Manifestations of attitudes cannot be seen directly, but only interpreted in advance from closed practices through implementation, interviews, or questionnaires.

Limited knowledge of nutrition and health in adolescents, especially those related to anemia, causes adolescent females to adopt eating habits that can be detrimental to their health. Health promotion in the modern era should benefit from technological development to ease the spread of information (Mishra, Gupta, & Shree, 2020). The new technology in information technology (ICT) has created an improvement and quality that has an essential impact on health education about topics of prevention, diagnosis, and treatment of disease (Arum et al., 2025; Tombokan, Purwandari, & Tuju, 2025). ICT gives accessibility not only for health practitioners to

perform health promotion, but also impacts people and society. Concerning the goal of this study, it has been proven that online health promotion to adolescent females can improve their knowledge, attitude, and practices to prevent anemia.

The use of digital platforms is critical to navigate the complex landscape of modern healthcare which influences long-term health outcomes (Cavicchiolo et al., 2022). An experimental study for adolescent girls regarding iron deficiency was performed using an interactive game. It shows that it can increase the level of knowledge, attitude, and practices about diet ($p < 0.05$) (Ghadam et al., 2023). This shows that educational digital platforms can serve adolescents based on the advancement of technology, and they are adaptable to use them. However, no significant effect was observed in the iron deficit, as its purpose. The study has analyzed that the use of digital platforms can function as tools of education, which has a significant impact on practices. The research is in line with recent randomized and quasi-experimental eHealth/mHealth trials in low-resource settings have likewise reported improvements in knowledge and adherence to iron supplementation, and some have documented modest increases in hemoglobin when education was combined with service linkage or reminders (Rahman et al., 2023). Another example of using a lightweight application, i.e., a WhatsApp-based anemia e-leaflet, was also conducted for young women for health promotion. However, this has fewer subjects for 20 respondents and involves only evaluating the design of the e-leaflet. Nevertheless, the results indicate that using WhatsApp as the tool to share anemia e-leaflet is feasible, as it has been through expert validation, with an 88% score very good for the e-leaflet. Despite the online leaflet, some evidence suggests a face-to-face program to support greater sustained practices change, underscoring that digital tools are most effective when they incorporate interactive elements, peer support, and linkage to services rather than being purely informational (Doshi & Bende, 2025). This study has integrated the materials which still delivered face-to-face through online media, i.e., Zoom meetings. So, it doesn't eliminate the essential of education of face-to-face interaction, even though through online platforms, everyone can still interact. Taken together, our findings improved knowledge, attitude, and practices following a structured module with reinforcement are consistent with international studies showing benefits from digital and blended formats.

This study acknowledges limitations. The baseline finding of 100% negative attitudes may not necessarily indicate a total lack of positive perception among participants, but rather a limitation of the measurement scale used. The questionnaire items may have been too stringent or insufficiently sensitive to detect moderate or neutral responses. Future studies are recommended to refine and validate the attitude scale further, including more nuanced response options to better capture variations in participants' baseline perceptions. Additionally, the self-reported questionnaires may desirably bias or overestimate the true level. Second, the potential confounders such as socioeconomic status, dietary intake, prior anemia education, and menstrual cycle were not fully controlled. Future research should employ a larger, more diverse sample and include biological measures such as hemoglobin or ferritin levels to strengthen the validity. Despite the limitations, the findings of the study have significant practical implications for health education, as Online health promotion accompanied by a module for learning can serve as an effective method for school-based health programs. Furthermore, collaboration between schools, health centers, and authorities can ensure sustainability of the implication as it is accessible among adolescents towards digital learning platforms. Continuous monitoring and adaptation will help ensure that the method of online health promotion remains relevant, engaging, and aligned with the evolving digital learning landscape of adolescents.

CONCLUSION

Online health promotion has a significant impact on the knowledge, attitude, and practices of adolescent females. Despite several limitations on self-reported data, uncontrolled confounding factors, the findings provide valuable insight for future implementation to integrate online health promotion. Future studies should use a larger and more diverse sample to strengthen validity, such as including the socioeconomic status, dietary intake, prior anemia education, and menstrual cycle, which are also potential influences on the results.

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