DEVELOPMENT OF THE ANEM SIP EDUCATION MODEL FOR ANEMIA PREVENTION IN ADOLESCENT GIRLS

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ABSTRACT

Anemia remains a common health issue among women aged 15–48 years, with a global prevalence of 30% and 18% in Indonesia. Various educational methods have been employed, yet the demand for Android-based educational models remains high. This study aimed to develop and evaluate the effectiveness of the *Anem SIP* educational model for anemia prevention in adolescent girls, using a mixed methods approach and the ADDIE development model. The study adopted a mixed methods approach with the ADDIE development framework. The product was developed through validation by four experts, followed by one-on-one testing, small group testing, and field trials. The needs assessment stage served as the foundational step in the development process. Interviews with stakeholders and a survey of 30 adolescent girls indicated a continued need for an Android-based educational model. The model was designed based on the Health Belief Model (HBM), supported by the PRECEDE-PROCEED model, Social Cognitive Theory (SCT), Transtheoretical Model (TTM), multimedia learning, and the Technology Acceptance Model (TAM). The final product was the *Anem SIP* mobile application, featuring promotive, preventive, diagnostic, and monitoring components for iron-folic acid (IFA) supplement intake. Validation by four experts confirmed the model's feasibility, and testing showed it to be user-friendly. The model comprises six procedural stages: problem identification, initial evaluation, preparation, action, final evaluation, and maintenance. Field testing revealed significant improvements in knowledge, attitudes, and adherence to IFA supplement consumption before and after the intervention. The t-test showed statistically significant increases in knowledge and attitudes (p < 0.001). Laboratory examinations also indicated an increase in average hemoglobin levels post-intervention. The *Anem SIP* intervention demonstrates promising potential in enhancing knowledge, attitudes, and behavioral changes among adolescent girls for the prevention of anemia.

ABSTRAK

Anemia masih menjadi masalah umum pada perempuan usia 15–48 tahun, dengan prevalensi global sebesar 30% dan 18% di Indonesia. Berbagai metode edukasi telah digunakan, namun kebutuhan akan model berbasis Android masih tinggi. Penelitian ini bertujuan mengembangkan dan menguji efektivitas model edukasi Anem SIP untuk pencegahan anemia pada remaja putri, menggunakan pendekatan mixed methods dan model pengembangan ADDIE. Studi ini menggunakan pendekatan mixed methods dengan model pengembangan ADDIE. Produk dikembangkan melalui validasi oleh empat pakar, diikuti dengan uji coba satu lawan satu, uji kelompok kecil, dan uji lapangan. Tahapan analisis kebutuhan merupakan landasan utama dalam proses pengembangan model edukasi ini. Wawancara dengan pemangku kepentingan dan survei terhadap 30 remaja putri menunjukkan masih tingginya kebutuhan akan model edukasi berbasis Android. Model dirancang berdasarkan Health Belief Model, serta didukung oleh teori PRECEDE-PROCEED, SCT, TTM, multimedia, dan TAM. Hasilnya adalah aplikasi mobile Anem SIP yang memiliki fitur promotif, preventif, diagnostik, dan pemantauan konsumsi IFA. Validasi oleh empat ahli menyatakan model ini layak, dan uji coba menunjukkan aplikasi mudah digunakan. Model terdiri dari enam tahap: pengenalan masalah, evaluasi awal, persiapan, aksi, evaluasi akhir, dan pemeliharaan. Hasil uji lapangan menunjukkan peningkatan skor rata-rata pengetahuan, sikap, dan kepatuhan terhadap konsumsi suplemen IFA sebelum dan sesudah intervensi. Uji t menunjukkan adanya peningkatan yang signifikan secara statistik dalam pengetahuan dan sikap (nilai p < 0,001). Selain itu, pemeriksaan laboratorium menunjukkan peningkatan rata-rata kadar hemoglobin pasca intervensi. Intervensi melalui Anem SIP terbukti berpotensi efektif dalam meningkatkan pengetahuan, sikap, dan perubahan perilaku remaja putri dalam upaya pencegahan anemia.

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INTRODUCTION

Anemia is a condition in which the level of hemoglobin (Hb) in the blood is lower than normal. Anemia among woman aged 15-48 years remain prevalent. According to WHO (2021), the global prevalence of anemia among woman is 29,9% (WHO, 2021). In Indonesia, data from the 2023 national health survey show that 15.5% of adolescent girls (aged 15-24 years) are anemic. Additionally, data from the Jambi Provincial Health Office (2023) indicate taht the incidence of anemia among adolescent girls is 8.17%, with the highest proportion in Muaro Jambi Regency at 65.92% (Jambi Provincial Health Service, 2023).

Adolescent girls, as part of the reproductive age group, are at a higher risk of iron deficiency anemia, particularly during the menstrual cycle (Jamnok *et al.*, 2020); McDaniel Jenny & Caryn Sorge, 2019; WHO, 2011). Research by (Dina Larinci et al, 2021) revealed a significant relationship between the duration of menstruation and anemia symptoms in adolescent girls (p-value < 0.05). Menstrual blood loss exceeding 80 ml often occurs in those experiencing prolonged periods lasting more than 3-5 days (Sheriff et al., 2021; Endale et al., 2022). Other contributing factors to anemia in adolescent girls include inadequate iron intake to meet the demands of rapid growth and development, as well as dieting behaviors linked to ideal body image perception, which can lead to reduced food consumption or even starvation. The widespread consumption of junk food—high-calorie products rich in unhealthy fats— also poses serious health risks (Mititelu et al., 2023).

Anemia causes fatigue and decreased concentration, which negatively affect academic achievement and productivity. It also weakens the immune system, increasing susceptibility to infections. If left untreated, anemia during adolescence may persist into adulhood, contributing significantly to higher maternal mortality rates (MMR), and increasing the risk of giving birth to low birth weight (LBW) babies and stunted children (Ministry of Health, 2016). Iron Deficiency Anemia (IDA) during pregnancy is associated with increased risks of prematurity, LBW, and low iron stores in newborns. These conditions raise the likelihood of stunting due to impaired fetal growth and development, both in utero and in the early months of life. This occurs due to insufficient iron transfer from mother to fetus, disrupting metabolism, bone growth, *erythropoiesis,* and the immune cell development (WHO, 2020).

Several studies have confirmed a link between maternal anemia and stunting in toddlers (Rahayu et al., 2023; Engla P & Hafiza F, 2023). Vitaloka et al (2019) reported that children born to mothers with a history of anemia during pregnancy are 3.2 times more likely to experience stunting (Vitaloka F S et al., 2019). (WHO, 2013) set a target to reduce anemia prevalence in women of childbearing age by 50% by 2025. In response, the Indonesian government implemented intensified preventive and management strategies for adolescent anemia (aged 12-18), prioritizing monthly iron-folic acid (IFA) supplementation (Ministry of Health, 2016). Studies have shown that IFA supplementation is positively associated with higher hemoglobin level (Gosdin L et al., 2021). For instance, women receiving 0.4 mg and 2.8 mg folic acid weekly had increased mean RBC folate (Samson et al., 2020). A three-months weekly IFA supplementation (WIFAS) intervention led to significant improvements in serum folate (4.10 ng/ml), ferritin (39.1 μg/l), and hemoglobin (1.2 g/dl) levels (Handiso et al., 2021).

One effective strategy for preventing anemia is to improve knowledge, attitudes, and behavior. *The Health Belief Model* (HBM) (Green *et al.*, 1980), explains individual decision-making related to behavior change. According to the PRECEDE-PROCEED model, health behavior is influenced by three interrelated factors: *predisposing*, *enabling,* and *reinforcing factors*. In addition to individual perception factors, *Social Learning Theory* (SCT) highlights the influence of perception, cognitive processes, and social environment on health behavior. *The Transtheorical Model* (TTM) outlines six stages of behavioral change: *pre-contemplation*, *contemplation,* preparation, action, maintenance, and termination (Prochaska James et al., 2017).

Various educational methods have been utilized to prevent anemia, including seminars, lectures, videos, video modules, e-learning modules (Gandhi S, 2019; Rahimi Bahrol et al, 2018), booklets, posters, brochure (Jalambo M et al., 2018) leaflet (Emilia Ova et al., 2019), *focus group discussions* (FGD), *observation* (Yilma H et al., 2020), webinars (Wahid H et al, 2021), anemia free clubs (Zuraida *et al.*, 2020), nutritional counseling (Shet Arun *et al.*, 2019; Singh et al, 2020). Education using *Android platforms* has also been developed, such as the "Teenagers Against Anemia" app (Ciptaningtiyas R, 2017) and the Aneminfo *android* application, which includes reminder features for IFA supplement intake (Saraswati, 2020). Intervention through *WhatsApp reminders* (Dewi Det et al., 2019; Elsharkawy N et al., 2022), and w*ebsites* like "She Smart*"* (Ernawati P & Hafiza F, 2022*;* Moradi A et al., 2017) has also been introduced. Despite these efforts, awareness among adolescent girls remains low. Only 5.2% of girls aged 15-24 have heard of low Hb, and only 8.4% are aware of anemia. In Jambi Province, this figures are even lower at 0.6% and 0.8% respectively (Ministry of Health, 2018).

Although government policies IFA supplementation for woman of childbearing age, the coverage has not met expectations. Nationally, the coverage of IFA supplementation among girls aged 10-19 is 76.2% (Ministry of Health, 2018). In Jambi Province, it is slightly lower at 71.62%, and in Jambi City it drops further to 67.88% (Badan Litbangkes Kemenkes RI, 2018). Among the reasons for low compliance are mostly (20,28 %) forgetfulness, lack of perceived need, or taking IFA only during menstruation. At the policy level, health workers may distribute IFA supplements but fail to ensure follow-up or monitor compliance (Yilma H et al., 2020).

The *Anem SIP* application was selected as the educational medium in this study because of its accessibility via smartphones—a device that young women frequently use to seek information. Multimedia-based health education is widely recognized for its potential in health promotion and intervention. Digital applications are increasingly utilized for public health promotion due to their efficiency and innovative capabilities in automating previously manual tasks (Manapurath R, Raran Veetil D, 2023). The Anem SIP application (Leonita E & Jalinus N, 2018) adheres to multimedia principles, being accessible anytime and anywhere (Meyer Richard, 2009), with broad coverage and integration capabilities (Darmawan, 2011). Importantly, the app includes features not typically found in similar tools: a diagnostic feature that screens for anemia based on symptoms experienced by adolescent girls, and a monitoring feature to track IFA supplement compliance. The diagnostic feature guides users in self-assessing anemia symptoms and encourages hemoglobin testing if necessary. The monitoring feature allows health workers to evaluate IFA consumption patterns in the community.

METHOD

This study employed a Research and Development (R&D) design using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. A mixed methods approach was adopted, with qualitative methods applied during the design phase and quantitative methods during product testing. In the initial phase, the study identified problems and conducted an analysis of instructional needs, as well as contextual analysis related to anemia prevention. Data were collected through questionnaires administered to 30 adolescent girls and interviews with key stakeholders, including health workers. The next steps involved formulating research objectives, designing research instruments, and developing an initial prototype of the educational application. Data collection at this stage also included brainstorming sessions with practitioners and experts in reproductive health and nutrition.

The initial prototype was validated by four experts in relevant fields. Specifically, the theoretical construct in the academic paper was reviewed by a health promotion expert from Gadjah Mada University (UGM). The *Anem SIP* intervention product was validated by four validators: (1) a health promotion expert from UGM, (2) an information technology expert from Polytechnic of Administrative Science - Indonesian State Administration, Bandung, (3) an educational technology expert from Jambi University, and (4) a practitioner from the Jambi Provincial Health Office. Following validation, a one-on-one usability test was conducted with three adolescent girls, selected based on varying educational backgrounds. This was followed by a small group test involving nine participants. Participant selection for both tests was based on education level and was guided by interview protocols, observation techniques, and qualitative data collection procedures, in line with *Creswell and Poth* (2018) model.

The final phase of the research involved a large group field trial conducted over three months, from February to May 2023, in Tangkit Baru Village, Muaro Jambi Regency, Jambi Province. The trial employed a one-group pretest-posttest design as a weak experimental approach. Thirty adolescent girls meeting the inclusion criteria (aged 18–20 years and not suffering from chronic diseases such as pulmonary tuberculosis, malaria, intestinal worms, or HIV/AIDS) participated in the trial. Data collection included a validated questionnaire measuring knowledge, attitudes, and compliance with IFA supplement consumption, with compliance data obtained through the monitoring feature in the *Anem SIP* application. Hemoglobin (Hb) levels were measured using venous blood samples analyzed with a hematology analyzer at the Jambi Ministry of Health Polytechnic Laboratory. The diagnosis of anemia was determined based on the WHO classification (WHO, 2011). Ethical approval for this research was obtained from the Research Ethics Committee of the Jambi Ministry of Health Polytechnic (approval number: LB.02.06/2/66/2023).

RESULT

1. Research Results of Needs Analysis Stage

The needs analysis stage was conducted in July 2022. The participants involved in this stage were key stakeholders, including the head of the nutrition program at the Jambi Provincial Health Office, the nutrition officer at the Paal V Health Center in Jambi City, the officer in charge of reproductive health at the Tangkit Health Center, the village midwife of Tangkit Baru Village, and 30 adolescent girls.

The analysis identified several key issues. According to stakeholders from the Jambi Provincial Health Office, the prevention of anemia among adolescent girls is part of the Ministry of Health's priority agenda to accelerate stunting reduction. This is implemented through the Nutrition Action Program, which includes activities such as promoting balanced diets, encouraging breakfast habits, and the weekly consumption of iron-folic acid (IFA) supplements at school (1 tablet per week). In contrast, adolescent girls in the community must obtain IFA supplements independently. Information provided by officers responsible for nutrition and reproductive health at the health centers indicated that while schools have programs for distributing IFA supplements and conducting anemia screening, similar programs are lacking in the community. According to the village midwife, cadres for anemia prevention have been formed but are not functioning as expected. As a result, adolescent girls in the community have not received IFA supplements and have not undergone anemia screening, leading to a lack of reliable data on anemia prevalence.

2. Design Phase Research Results

The design phase of the anemia prevention educational model began by referring to the results of the needs analysis and the validity of the theoretical constructs used. The process continued with product conceptualization, identifying key requirements, conducting expert consultations, and forming a development team composed of educational content developers and information technology programmers. The educational model developed is named *Anem SIP*. The design process started with the creation of a storyboard—a visual sketch that outlines the sequence of content delivery using text, images, and videos.

Anem SIP was developed as an Android-based application tailored to the needs of adolescent girls. The application includes four main features: promotive, preventive, diagnostic (for identifying signs and symptoms of anemia), and a monitoring feature to track Fe supplement consumption. In addition to the adolescent user interface, *Anem SIP* also provides a monitoring platform for health workers and village midwives. This component allows them to receive real-time reports on IFA supplement consumption submitted by adolescent users through the application.

3. Research Results of Development Phase

a. Expert Validation

The validation of the academic manuscript, which synthesizes the theoretical constructs underpinning the anemia prevention education model, was conducted by health promotion experts from Gadjah Mada University (UGM). The experts confirmed that the manuscript accurately reflects behavior change theory in the context of anemia prevention among adolescent girls. The intervention stages were found to align with health promotion theory, and the behavioral change

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components were deemed consistent with the intended outcomes: improved knowledge, attitudes, and compliance with IFA supplement consumption, as well as increased hemoglobin levels.

Following revisions based on input from four validators, the validation results for the intervention product concluded that the *Anem SIP* educational model is consistent with the theoretical constructs related to anemia prevention in adolescent girls. The intervention stages were again affirmed to reflect health promotion theory, and the behavioral change framework was aligned with the targeted outcomes. The validators concluded that the *Anem SIP* intervention product was suitable to proceed to the next phase of testing.

b. One-on-One test

One-on-one testing was conducted through observation and interviews with three adolescent girls, selected based on their educational backgrounds. The first participant was a university student in Jambi City; the second was a junior high school graduate; and the third was a high school graduate currently employed as a private sector worker.

The results of the one-on-one testing indicated that the *Anem SIP* educational model was well-received. The information and messages presented in the application were reported to be clear, easy to understand, efficient, user-friendly, and engaging.

c. Small Group Test

The purpose of the small group testing was to ensure that the product is genuinely user-friendly and to observe the preliminary impact of using the *Anem SIP* educational model. This test involved nine adolescent girls, selected based on educational background: three were high school graduates, three were students, and three were employed as private workers and small-scale entrepreneurs (specifically, involved in processing pineapple products into snacks).

Observations during the testing showed that the participants were able to follow the instructions and navigate the application with ease. The educational content was easy to understand, as it used simple language tailored to the needs of adolescent girls, making it accessible and user-friendly. The product was considered acceptable in terms of technological development, ease of use, and environmental support. Its usability was enhanced by the accessibility of Android devices, which were available to all participants.

4. Implementation Stage

The field trial was conducted with 30 adolescent girls in Tangkit Baru Village over a 10-week period, from February 26 to May 28, 2024. At the first meeting, prior to the intervention, a pre-test was administered. This included the completion of a questionnaire to assess knowledge, attitudes, and behaviors related to IFA supplement consumption, followed by the measurement of hemoglobin (Hb) levels. Each participant received one blister pack of IFA supplements containing 10 tablets. They were instructed to begin consumption immediately and to take one tablet per week for 10 weeks. During this intervention period, the participants also used the *Anem SIP* application. Health workers (village midwives) monitored IFA supplement consumption via the health worker monitoring feature integrated into the app. After the 10-week intervention, a post-test was conducted at the second meeting. This evaluation consisted of a repeated questionnaire to assess changes in knowledge, attitudes, and behaviors, followed again by Hb level measurements. The validity of the instruments used to measure knowledge and attitudes was tested using the Pearson Product-Moment correlation method and was found to be valid. The reliability of the instruments was assessed using Cronbach's Alpha, with results indicating acceptable reliability for both knowledge ($\alpha = 0.75$) and attitude ($\alpha = 0.73$). The characteristics of respondents in the field trial can be seen in Table 1.

Table 1 shows that one respondent is employed as a private sector worker after completing high school education. The majority of respondents' parents, both fathers and mothers, have attained a high school level of education. Most families have a monthly income of less than 4 million rupiah. None of the respondents reported a history of chronic diseases that could increase the risk of anemia in adolescent girls. The results of the field trial examining the impact of the *Anem SIP* educational model on knowledge, attitudes, compliance with IFA supplement consumption, and hemoglobin levels were analyzed using a paired t-test, as presented in Table 2.

Table 1. Frequency Distribution of Respondent Characteristics (n= 30)

Respondent Characteristics	n	%
Education Level		
Elementary/Middle School	10	33.3
High School	10	33.3
Higher Education	10	33.3
Occupation		
Working	1	3.3
Not Working	19	63.4
Student	10	33.3
Father's Education		
Elementary/Middle School	10	33.3
High School	17	56.7
Higher Education	3	10.0
Mother's Education		
Elementary/Middle School	9	30.0
High School	17	56.7
Higher Education	4	13.3
Parental Income (IDR)		
< 4 million	25	83.3
5-10 million	5	16.7
> 10 million	0	0.0
History of chronic disease		
No	30	100.0
Yes	0	0.0

Table 2. Field Test Results on Knowledge, Attitude, Compliance Behavior, and Hb Levels (n=30)

Research Variables	Mean	P-value
Knowledge		
Pre-test	5.6	0.000
Post-test	9.8	
Attitude		
Pre-test	52.6	0.000
Post-test	89.3	
Compliance with IFA supplement consumption		
Compliant	0.0	-
Not-Compliant	30.0	
Hemoglobin Level (g/dl)		
Pre-Test	12.4	0.000
Post-Test	13.3	

Table Table 2 presents the results of the study, showing an increase in the average scores for knowledge and attitudes of adolescent girls toward anemia prevention before and after a three-month intervention using the *Anem SIP* application. The paired t-test analysis indicated statistically significant differences in both knowledge and attitude, with p-values of < 0.001 for each.

The study also demonstrated a change in compliance behavior related to IFA supplement consumption. Prior to the intervention, adolescent girls in Tangkit Baru Village were not compliant with IFA supplement intake, primarily due to a lack of distribution from health workers or the local health center. During the intervention, participants were provided with IFA supplements and instructed to consume one tablet per week. They were also required to report their weekly consumption via the monitoring feature in the *Anem SIP* application, which was connected to a corresponding feature

accessible by health workers. Laboratory examination results showed an increase in the average hemoglobin levels after the intervention. The t-test analysis produced a p-value of < 0.001, indicating a statistically significant improvement in hemoglobin levels among the participants following the intervention.

This study presents two key novelties: first, the conceptual framework of a behavior change model specifically for preventing anemia in young women; and second, the application of Anem SIP. The following is the conceptual framework of the behavior change model for preventing anemia in adolescent girls.
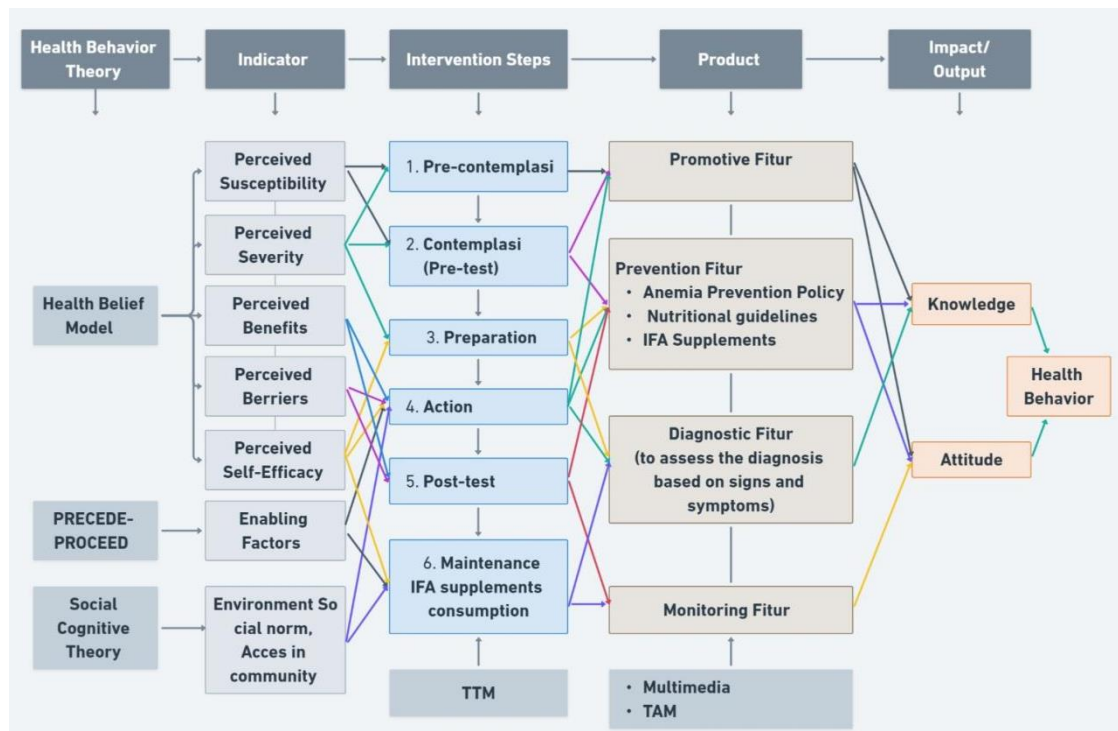

Figure 1 Conceptual Framework of Behavior Change Model for Anemia Prevention in Adolescent Girls

The results of the synthesis of theory and literature related to the theoretical constructs underlying the development of an educational model for preventing anemia in adolescent girls point to the HBM Theory as the primary framework. This theory is combined with the PRECEDE-PROCEED model and Social Cognitive Theory (SCT). The 'Anem SIP' educational model, which utilizes an Android application, is further supported by multimedia and the Technology Acceptance Model (TAM). According to the HBM, adolescents' decisions regarding health behaviors, particularly in preventing anemia, are influenced by various factors, including the information they receive from different sources, such as the anemia prevention education model designed for adolescent girls.

This concept, when applied to health-related behavior, can be interpreted as the desire to remain healthy (value) and the belief that certain health actions can prevent or treat illness (expectation). This expectation is reflected in adolescent girls' assessment of their risk of developing anemia, the perceived severity of the condition, and the belief that specific actions can reduce the threat of the disease. The Health Belief Model (HBM) comprises three key components: background factors, perceptions, and actions.

DISCUSSION

The development process of the anemia prevention education model was carried out in five stages: needs analysis, design, product development, implementation, and evaluation. The problem analysis was based on the high prevalence of anemia among adolescent girls and the potential complications if

left unaddressed. Globally, the prevalence of anemia among adolescent girls ranges from 40% to 88% (WHO, 2013), In Indonesia, 32% of women aged 15–24 are anemic, with data indicating that 3 to 4 out of 10 women suffer from anemia (Ernawati P & Hafiza Fil Ihsan, 2022). Adolescents are in a critical period of growth and development. Factors such as menstrual blood loss, inadequate iron intake, pursuit of an ideal body image, and the widespread consumption of junk food contribute to an increased risk of anemia—particularly iron deficiency anemia. Barriers to effective iron and folic acid (IFA) supplementation include challenges at the policy and implementation levels. Although health workers distribute IFA supplements, there is often a lack of follow-up regarding adherence to supplement consumption (Yilma H et al., 2020).

Literature analysis related to educational efforts aimed at changing adolescent girls' behavior in preventing anemia indicates that the Health Belief Model (HBM) is a relevant behavior change theory. HBM explains the decision-making considerations involved when adolescent girls choose to engage in health-promoting behaviors. In addition to individual perception factors, behavior is also shaped by the social environment in which the adolescent resides, as emphasized by Bandura's Social Cognitive Theory (SCT). According to SCT, behavioral change is influenced not only by personal cognitive processes but also by environmental factors and the availability of supporting facilities, such as iron and folic acid (IFA) supplementation. The SCT approach also highlights the role of conditioning (habitual response) and imitation (modeling behavior) in social development. In this context, peer groups and role models play a critical role in shaping adolescent girls' social behavior and health practices.

This educational model provides several benefits. For adolescent girls, it facilitates access to information regarding anemia prevention, helps in recognizing the signs and symptoms of anemia, and supports the self-evaluation of their compliance with IFA supplementation. For health workers at community health centers (Puskesmas), the model assists in monitoring and evaluating the consumption of IFA supplements among adolescents within their service areas. Furthermore, the model serves as a reporting tool for health workers and program managers responsible for adolescent reproductive health.

The selection of this educational model as a health promotion tool is based on its accessibility via smartphones. In today's digital era, adolescent girls are highly engaged with smartphones as a primary source of information. This is aligned with the principles of multimedia learning, which suggest that multimedia should be accessible anytime and anywhere (spatial and temporal proximity) (Meyer Ricard, 2009), have wide reach, and be integrated with other systems (Darmawan, 2011). Previous studies also support the effectiveness of multimedia in health promotion (Ren Wen et al, 2015), highlighting its potential to reach diverse target groups and promote behavior change (Leonita E, 2018).

With the rapid growth of technology, smartphone usage has significantly increased both globally and in Indonesia. In 2021, the number of smartphone users worldwide reached 5.3 billion. According to Statistic Indonesia (Central Bureau of Statistics, 2022), 65.87% of Indonesians aged five and above owned smartphones, and this figure rose to 67.88% in 2022 (Central Bureau of Statistics, 2022). Smartphone features now cater to a wide range of user needs, including access to health information (Saraswati et al, 2020), starting that the Android-based application "Aneminfo" effectively increased knowledge and reminded young women about anemia prevention through education on iron deficiency anemia.

The "Anem SIP" educational application is specifically designed to meet the needs of adolescent girls. The application adopts a complex multimedia format that integrates video, audio, text, images, and animation—elements shown to be more engaging and easier to understand for young users. The design of this educational model adheres to the seven principles of multimedia learning: multimedia principle, spatial proximity, temporal proximity, coherence, modality, redundancy, and individual differences (Meyer Ricard 2009).

A one-on-one assessment was conducted to evaluate the practical usability of the anemia prevention education model. According to Rusdi (2019), the purpose of this assessment is to ensure that the product is user-friendly, enjoyable, and easy to use. It also helps identify usability issues, enhance design procedures, determine early performance indicators, and gather feedback on user experiences regarding the content and messages delivered by the application (Rusdi M, 2019). The assessment involved three adolescent girls as participants. Each participant tested and evaluated the design,

usability, and engagement level of the "Anem SIP" application. Participants were selected to reflect different educational backgrounds to capture diverse perspectives.

Data from the observations and interviews were analyzed inductively using a bottom-up approach in accordance with the qualitative analysis framework of Creswell & Poth (2018) model (Rusdi M, 2019). During this phase, researchers interacted individually with each adolescent participant. The results of the one-on-one assessment were used to revise and improve the educational model, enhancing its validity and effectiveness for future use.

Small group assessment serves as a transitional phase between individual assessment and field testing (Rusdi M, 2019). The main purpose of this assessment is to ensure that the anemia prevention education model is truly user-friendly and practical for its intended users. In this study, the small group trial involved nine female adolescents. The number of participants was determined based on guidelines provided by M. Rusdi (Rusdi M, 2019), which recommend a sample size of 9 to 20 individuals for small group assessments.

Multimedia has proven to be effective in improving knowledge, attitudes, iron adequacy levels, and compliance with iron tablet consumption among pregnant women (Munawaroh Aqila et al, 2019). A study conducted by Singh (Singh M et al, 2019) in Mumbai, concluded that counseling combined with nutritional supplementation is effective in preventing anemia among women of reproductive age. A systematic review by Al Mamun and Hamza (Al Mamun, Hamza, 2015) found that Facebook group activities related to hypertension information were driven by users' awareness and motivation to seek health knowledge. Furthermore, a review by Sarinah Siregar (Sarinah Siregar et al, 2022), demonstrated that health education interventions, along with the provision of IFA supplements and multivitamins, are effective in addressing iron deficiency anemia among adolescent girls. These educational interventions also significantly improved their knowledge regarding iron deficiency.

This research is also supported by a study conducted by Ciptaningtyas (2017), which showed that the use of Android-based applications is more effective compared to the IFA supplementation programs implemented by health workers in schools. Similarly, research by Septia Riski (Saraswati et al, 2020), in two vocational schools in Semarang City found that the Android application "Aneminfo" is an effective tool for increasing knowledge and reminding adolescent girls to prevent anemia early through educational content about iron deficiency anemia within the app. In line with this, a study by Khanna (Khanna P et al, 2021) in India highlighted that health education delivered through periodic interventions—such as webinars and role plays—can be highly effective. Moreover, a study by Adlu R and Fadhila F (Adlu R & Fadhila F, 2023) concluded that audio podcasts are also effective in enhancing knowledge about anemia among adolescent girls.

The most notable behavior observed among the respondents was their compliance in consuming IFA supplements. Prior to the intervention, none of the adolescent girls regularly consumed IFA supplements. However, following the intervention, all participants began taking the supplements consistently. This improvement in compliance was supported by the availability of IFA supplements, which were provided in collaboration with the local health center through village midwives.

The compliance of adolescent girls in consuming IFA supplements aligns with WHO recommendations through a program aimed at intensifying preventive efforts and managing anemia among adolescent girls (aged 12–18 years) and women of reproductive age. This program prioritizes the provision of IFA supplements, which are distributed monthly throughout the year, totaling 52 tablets annually (Ministry of Heatlh, 2016). Several studies have shown that supplementation with tablets containing 120 mg of ferrous sulfate and 3.5 mg of folic acid significantly increases mean plasma ferritin levels among adolescent girls after receiving treatment (Tee E et al, 1999).

According to Singh (2019), counseling and the use of effective nutritional supplements play a vital role in preventing nutritional deficiencies such as anemia. Furthermore, education or counseling provided to parents has been shown to improve anemia recovery rates in preschool children by increasing compliance with IFA supplement consumption (Shet et al, 2019). Similarly, research by Ciptaningtiyas R, (2017) demonstrated that the use of Android-based applications is more effective than traditional modules in delivering IFA supplementation programs implemented by health workers in schools.

Hemoglobin levels were measured before and after the intervention. The results indicated an increase in the average hemoglobin levels following the intervention, and statistical analysis confirmed a significant difference. This suggests that the anemia prevention education model is effective in reducing the incidence of anemia among adolescent girls. This finding aligns with the research by Khanna (Khanna P et al, 2021) in India, where the prevalence of anemia decreased from 40.65% to 25.95%—a reduction of 15%—after implementing a nutritional intervention package combined with a multimedia approach over a six-month period.

The conceptual framework for the anemia prevention education model integrates the Health Belief Model (HBM) as the primary theoretical construct, supplemented by the PRECEDE-PROCEED and Social Cognitive Theory (SCT). According to the HBM, adolescents' decisions regarding health behaviors, particularly in preventing anemia, are influenced by various factors, including the information they receive from multiple sources, such as the Anem SIP education model. The validity of the HBM constructs is supported by key elements like perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. This framework is reinforced by research conducted by Ghaderi (Ghaderi N et al., 2017) which demonstrated that HBM-based education effectively improved knowledge, attitudes, and behaviors related to the prevention of iron deficiency anemia among female high school students in Iran.

The validity of the PRECEDE-PROCEED theory constructs is reflected in the enabling factors, such as the availability of health workers (village midwives) and the accessibility or affordability of IFA supplements, which are crucial in efforts to prevent anemia in adolescent girls. Research by Eftekhar Ardebili and Bagheri (Eftekhar Ardebili, Bagheri F, 2018) demonstrated that educational interventions using the PRECEDE model significantly improved iron deficiency anemia prevention behaviors among junior high school students. Additionally, the validity of the Social Cognitive Theory (SCT) is evident in the environmental factors, particularly the role of peer and family support in encouraging anemia prevention behaviors.

CONCLUSION AND SUGGESTION

The Anem SIP education model for anemia prevention in adolescent girls has proven effective and was developed based on a synthesis of several health behavior change theories, particularly the Health Belief Model (HBM), PRECEDE-PROCEED, and Social Cognitive Theory (SCT). The model was designed using the ADDIE procedure and validated by four experts, with individual and small group trials demonstrating its user-friendliness. Intervention results showed a significant improvement in knowledge, attitudes, IFA supplement consumption behavior, and hemoglobin levels, with a p-value of 0.000. The research was conducted during the development stage with 30 respondents, and further large-scale studies using experimental methods without developer involvement are recommended.

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