The Effect of Implementing Health Education Technology to Increase Nutritional Literacy and Prevent Anemia in Pregnant Women

Abstrak

Aims: This study aims to analyze the effect of implementing health education technology in improving nutritional literacy and preventing anemia in pregnant women, as well as identifying the most effective technological approaches to support maternal and fetal health.

Instrument & Methods: A cross-sectional quantitative study was conducted at Balerejo Health Center, Madiun Regency, involving 132 pregnant women as samples. Data were collected through questionnaires (Likert scale), in-depth interviews, and medical records. Statistical analysis used Smart-PLS to test the reliability of the instrument (Cronbach's Alpha >0.6) and the relationship between variables (PLS regression). Four technological interventions were evaluated: mobile applications, e-learning, social media, and telemedicine.

Findings: All technologies have a significant effect on improving nutritional literacy and preventing anemia. Telemedicine has the largest effect (T-statistic = 2.861; p-value = 0.004) due to direct interaction with health workers. The R^2 value is close to 1.000 indicating that the technology variable explains most of the variation in the results. Although 84.1% of respondents are of ideal age (20–35 years) and 59.1% have adequate income, 40.9% of pregnant women still experience anemia, emphasizing the importance of nutritional education.

Conclusion: Implementation of health education technology, especially telemedicine, is effective in increasing nutritional literacy and reducing the risk of anemia in pregnant women. Recommendations include strengthening digital infrastructure in remote areas, digital literacy training, and monitoring evidence-based content. These findings support the development of sustainable technology-based maternal health policies.

Keywords: Health Education Technology, Nutritional Literacy, Anemia Prevention, Pregnant Women

INTRODUCTION

In the last few decades, the application of technology in various sectors has significantly improved people's quality of life [1]. One sector experiencing rapid development is the health sector, including health education, which aims to increase nutritional literacy and prevent various health problems, especially in vulnerable groups such as pregnant women [2]. Anaemia in expectant women remains a public health issue in numerous countries, including Indonesia [3]. This condition has the potential to negatively impact the health of both the mother and the foetus, as well as to elevate the likelihood of complications during pregnancy and labour [4].

Anaemia in expectant women is a condition characterised by haemoglobin levels in the blood that are below the normal range. This condition is typically caused by iron deficiency [5]. Data from the Indonesian Ministry of Health indicates that anaemia remains a significant cause of mortality for both mothers and neonates, with a high prevalence among pregnant women [6]. A variety of complications, such as premature birth, low birth weight, and impaired foetal growth and development, can result from anaemia. Consequently, it is crucial to make efforts to prevent anaemia in order to enhance the health of both mothers and infants [7]. A lack of nutritional literacy, specifically a lack of comprehension of the significance of adequate nutritional consumption during pregnancy, is one of the primary factors contributing to the high prevalence of anaemia among pregnant women [8]. Numerous expectant women are unaware of the significance of consuming recommended iron supplements during pregnancy, the methods to enhance iron absorption, and the food sources that are rich in iron [9]. Additionally, expectant women's food consumption patterns are adversely affected by social, economic, and cultural factors, which result in inadequate nutritional intake.

The development of digital technology has brought major changes in how people obtain information, including in the health sector [10]. Digital-based health education technology, such as mobile applications, e-learning, telemedicine, and social media, can be an innovative solution to increase the nutritional literacy of pregnant women [11]. The application of technology in health education allows the delivery of information that is more accessible, interactive, and based on

scientific evidence, which can increase the understanding and awareness of pregnant women regarding the importance of balanced nutrition and preventing anemia [12]. Several studies show that using technology in health education can increase the effectiveness of counseling compared to conventional methods [13]. Digital technology allows pregnant women to get real-time information, access educational materials anytime and anywhere, and interact directly with health workers through online platforms [14]. Apart from that, the use of applications and social media can also increase the involvement of pregnant women in health education programs, thereby accelerating changes in healthier behavior [15].

Several technological innovations that can be used in health education for pregnant women include mobile applications for nutrition education, e-learning and webinars, social media, digital content, telemedicine, and online consultations [16]. Health mobile applications can provide information regarding nutritional needs during pregnancy, healthy food menus, and reminders to consume iron supplements [17]. E-learning and webinars allow pregnant women to participate in online training programs involving professional health workers to provide education about nutrition and anemia prevention [18]. Utilizing social media platforms such as Instagram, YouTube, and TikTok is also an effective way to disseminate health information through educational videos, infographics, and interactive articles [19]. Meanwhile, telemedicine services and online consultations allow pregnant women to communicate with doctors or nutritionists directly to get personal recommendations regarding diet and nutritional supplements needed during pregnancy [20].

With these various technological innovations, pregnant women can obtain health information more easily and effectively [21]. However, the success of implementing technology in health education depends on factors such as technology accessibility, the level of digital literacy of pregnant women, and support from health workers and the government in developing and socializing the technology [22]. Although technology has great potential in increasing nutritional literacy and preventing anemia in pregnant women, several challenges must be considered in its implementation. Some of these challenges include limited accessibility and infrastructure, especially in rural or remote areas, and low digital literacy among pregnant women who are not yet accustomed to using digital technology [23]. Apart from that, the accuracy of information is also an important concern because disseminating unverified health information through digital media can be misleading. Therefore, ensuring that the educational content is based on scientific evidence and supervised by health professionals is important. The involvement of health workers is also very necessary in providing assistance and ensuring that pregnant women understand and apply the information obtained correctly [24].

The objective of this research is to investigate the impact of Health Education technology on the prevention of anaemia and the enhancement of nutritional literacy in expectant women. The objective of this research is to identify the most effective approach for utilising health education technology to provide health education to expectant women, thereby enhancing the well-being of both the mother and her unborn child. Additionally, the findings of this investigation may serve as a foundation for the development of more sustainable and effective technology-based education programs and policies by health agencies and the government. Therefore, the integration of technology into health education has the potential to enhance the quality of maternal and infant health by reducing anaemia rates in pregnant women. The application of technology in health education has great potential in increasing nutritional literacy and preventing anemia in pregnant women. By utilizing various digital platforms such as mobile applications, e-learning, social media, and telemedicine, pregnant women can obtain health information that is easier to access and understand. However, to ensure its effectiveness, a comprehensive approach is needed that considers existing challenges, including accessibility, digital literacy, accuracy of information, and involvement of health workers. Therefore, this research is an important step in identifying the best strategy to optimize the use of health education technology to improve the overall health of mothers and babies.

METHODS

Types of Research

The research method used is quantitative. In quantitative research, the main goal is to research a specific population or sample using structured research instruments. The data obtained were statistically analyzed to test the established hypothesis. The statistical method used in this study is *Partial Least Squares Structural Equation Modeling* (PLS-SEM). The selection of this method

is in accordance with the purpose of predictive research and involves several latent constructs such as mobile applications, e-learning, social media, and telemedicine in relation to nutritional literacy and anemia prevention in pregnant women. The use of PLS-SEM can be seen from the reliability testing of constructs through Composite Reliability and Cronbach's Alpha values, as well as hypothesis testing using t-statistical values, p-values, and *bootstrapping* techniques. One of the main advantages of PLS-SEM is that there is no need to assume data normality, so this method can still be used even if the data distribution is abnormal.

Research Location

This research was conducted at the Balerejo Community Health Center, Madiun Regency, one of the Community Health Centers with nutritional support and monitoring facilities for pregnant women. The Balerejo Community Health Center was chosen as the research location because it has many pregnant women and offers healthy lifestyle programs that can be research subjects. This research lasted for two months, namely from June to December 2024. This time was chosen to ensure that the data collected covered all aspects of the research objectives.

Population and Sample

The research uses *the total population sampling* technique. All pregnant women who carry out pregnancy checks at the Balerejo Health Center (total
132 pregnant women) were used as a sample.

To avoid selection bias, participants were randomly divided using *Random Allocation Software* into two groups:

- **Intervention group**: Pregnant women with multiple pregnancies
- **Control group**: Pregnant women with pregnancy disorders such as preeclampsia, hypertension, and gestational diabetes

Data Collection Techniques

Primer data

Obtained through questionnaires and interviews. The questionnaire used an ordinal scale to assess pregnant women's perceptions and experiences regarding nutritional literacy and anemia prevention. In-depth interviews delve into food consumption, awareness of the importance of iron, and the effectiveness of health education technology.

Data Seconds

Taken from the patient's medical records at the relevant healthcare facility, it includes**:**

1. Health conditions of pregnant women
2. Up to hemoglobin
3. History of pregnancy
4. Risk factors for anemia

Data Processing and Analysis

Data is managed using *SmartPLS* with editing, coding, tabulation, and grading processes. The analysis was carried out using:

- *Regression* to test the relationship between variables
- *Likert scale* (1 = strongly disagree to 5 = strongly agree) for the assessment of the questionnaire

RESULTS

Respondent Characteristics

Table 1. Distribution of frequency characteristics of respondents at the Balerejo Community Health Center, Madiun Regency, in 2024

Characteristics	N	(%)
Age		
<20 years or > 35 years	21	15,9
20 - 35 year	111	84,1
Entire	132	100
Education		
Elementary school	1	0,7
Junior high school	18	13,6

Secondary school	75	56,8
Diploma/Bachelor	38	28,9
Entire	132	100
Pregnancy spacing		
The first child	51	38,6
<2 year	12	9,1
>2 year	69	52,3
Entire	132	100
Parity		
≥3 time	58	43,9
<3 time	74	56,1
Entire	132	100
Nutritional status		
Good (LILA ≥23,5 cm)	93	70,5
Not enough (LILA <23,5 cm)	39	29,5
Entire	132	100
Income		
<2.243.000	54	40,9
≥2.243.000	78	59,1
Entire	132	100
Incidence of anemia		
Anemia	54	40,9
No Anemia	78	59,1
Entire	132	100

Most of the pregnant women involved in this study were at the ideal age for pregnancy, had a high level of secondary education, and were in good nutritional condition. The interval between pregnancies is generally more than two years, and most of them have only had one or two previous pregnancies. From an economic point of view, more than half of the respondents have a fairly good income, which is likely to help them in maintaining nutritional intake during pregnancy. This condition can support their health and the fetus they are carrying. Nevertheless, even though many mothers are in supportive conditions, there are still quite a few cases of anemia. This shows that the health of pregnant women is not only influenced by age or income, but also by their understanding of nutritional needs during pregnancy. These findings reinforce the importance of counseling and education about nutrition so that pregnant women can take better care of their health.

Table 2. Composite reliability and Cronbach alpha inspection results

Construction	***Cronbach's Alpha***	***Rho_A***	***Composite Reliability***	***Average Variance Extracted (AVE***
Mobile Application	0.758	0.917	0.717	0.568
E-Learning	0.675	0.885	0.752	0.544
Social media	0.613	0.723	0.768	0.651
Telemedicine	0.826	0.621	0.838	0.599
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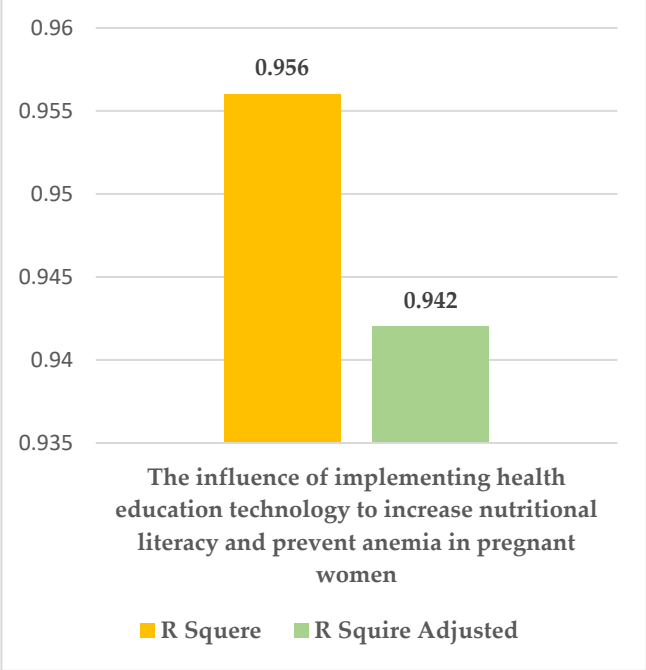
The measurement results showed that most of the aspects studied in this study had a good level of consistency. Mobile applications and telemedicine services appear to be more stable and reliable compared to e-learning and social media in delivering health education. This can be seen from the strength and uniformity of responses given by the participants. Although there is a slight difference in how strongly each approach is accepted, in general the tools used to assess the experiences of pregnant women are considered quite trustworthy. In fact, there is one approach that shows the best and most consistent results throughout the measurement, reflecting that the method is truly well understood and accepted by the users.

Graph 1. Regression results on the effect of implementing health education technology to increase nutritional literacy and prevent anemia in pregnant women



(Source: Author's processing of field data 2025)

The results of the study show that the use of health education technology has a huge impact in helping pregnant women understand the importance of nutrition and prevent anemia. The digital tools and methods used have been proven to be able to explain almost all aspects related to improving nutritional understanding.

Not only is this approach effective, it is also consistent and remains robust even when used in a variety of conditions. These findings reinforce the belief that technology-based education can be an effective solution to improve the health of pregnant women, especially in terms of nutritional literacy and anemia prevention.

To ensure that the results of this study can be trusted and truly reflect the conditions in the field, a process of repeated testing is carried out on the data that has been collected. In this process, the data was thoroughly analyzed to see the extent to which the relationship found between the use of health education technology and changes in pregnant women's understanding and behavior was reliable.

The approach used allowed the researcher to assess whether the results that emerged were not just coincidences, but actually reflected a real pattern. If the results of this test show high consistency, then it can be concluded that the findings in this study are quite strong and can be used as a basis for decision-making or the development of similar programs in the future.

Figure1. Bootstrapping output

(Source: Author's processing of field data 2025)

Table 3. Test the results of the examination based on the indicators used

Variable	*Original Sample (O)*	*Sample Mean (M)*	*STDEV*	*T-Statistics (|O/STDEV|)*	*P value*	*Hypothesis*
Mobile Application	0.252	0.251	0.093	2.580	**0.041**	**Accepted**
E-Learning	0.341	0.192	0.101	2.949	**0.050**	**Accepted**
Social media	0.269	0.248	0.078	2.852	**0.048**	**Accepted**
Telemedicine	0.437	0.471	0.154	2.861	**0.004**	**Accepted**

(Source: Author's processing of field data 2025)

The results of the analysis show that the use of technology in health counseling has a strong and real impact on improving nutritional understanding and anemia prevention in pregnant women. Some of the approaches used include mobile applications, online learning, social media, and remote health services.

Among the four approaches, remote health services (telemedicine) have the greatest influence, because they are able to provide direct consultation and education even without face-to-face. Mobile apps, social media, and e-learning have also proven to be significantly helpful, although online learning is slightly less effective than other approaches.

Thus, the comprehensive use of technology, especially those that are interactive and easily accessible, has proven to be a very helpful strategy in increasing the knowledge of pregnant women and encouraging healthy living behaviors.

DISCUSSION

Mobile Application

This mobile app provides important insights into how technology can be applied in efforts to prevent health problems that are often overlooked, such as anemia in pregnant women, which is a global problem. In this context, mobile applications not only serve as a means of disseminating information but also as a practical and efficient educational tool.

One of the important contributions of these findings is the app's ability to improve nutritional literacy in pregnant women. Better nutritional literacy allows pregnant women to understand their nutritional needs during pregnancy and, thus, can prevent conditions such as anemia. In addition, the app can also provide personalized recommendations, allowing pregnant women to adjust their nutritional intake based on personal health conditions. This is especially important because the prevention of anemia relies on an individual's knowledge of their nutritional needs, which is often poorly understood.

In addition, the active involvement of pregnant women in using mobile applications shows that technology can be a very valuable information bridge, especially in areas with limited access to health facilities. With the app, pregnant women can get accurate information about nutrition and anemia, even when health facilities cannot be accessed directly. This is also relevant considering the limited resources in some areas that may hinder pregnant women from accessing adequate nutritional information.

These findings align with previous research, which shows that using mobile applications in health education can increase users' understanding and awareness of health information. [25] found that mobile-based applications designed for nutrition education increased the involvement and understanding of pregnant women in managing nutritional intake. In addition, research by [26] also revealed that using health applications has a positive impact in increasing awareness about anemia prevention through interactive features and reminders for iron supplement consumption. However, the results of this study also show that the influence of mobile applications is not as big as some other variables, such as telemedicine. This may be due to limited accessibility, low digital skills of some pregnant women, or lack of direct interaction in the applications used.

E-Learning

E-learning has been proven to make a positive contribution in equipping pregnant women with the necessary knowledge to understand the importance of nutrition during pregnancy. This shows that the use of digital technology, although not the most dominant compared to other variables such as telemedicine, still has a significant impact on behavioral changes and health awareness.

The use of e-learning offers flexibility in delivering educational materials that can be accessed anytime and anywhere, making it an inclusive tool, especially for pregnant women who have limitations in accessing health services directly. In addition, the success of this approach also shows that digital learning media can bridge geographical and socio-economic limitations that are often obstacles in conventional health education programs.

A study conducted by [27] found that e-learning-based educational programs significantly improved participants' understanding of nutrition and maternal health compared to conventional methods. This is because e-learning allows access to information that is more flexible, interactive, and can be adjusted to individual needs. In addition, research by [28] also showed that pregnant women who participated in online-based educational programs were more likely to adopt a healthy diet than those who relied solely on regular medical consultations.

Social media

With its characteristics that are interactive, easily accessible, and able to reach a wide audience in a short time, social media is able to answer the challenge of disseminating nutritional information, especially for pregnant women. In this context, social media not only functions as a one-way communication channel, but also as a discussion space that allows for dynamic knowledge exchange between pregnant women and health workers or nutritionists.

User involvement in online communities is also one of the strengths of social media in shaping healthy behaviors. Active participation in health forums or groups encourages pregnant women to be more concerned about their body condition and nutritional needs. This shows that social media can create a collaborative and supportive learning environment, which is often not achieved in conventional educational methods.

Furthermore, the effectiveness of social media in improving nutritional literacy also shows the importance of adapting health promotion strategies to technological developments and people's behavior. In the digital age, social media-based approaches have the potential to expand the reach of public health interventions at a relatively low cost but with a wide impact. Therefore, social media can be one of the important components in designing a more comprehensive and sustainable anemia prevention program.

This finding aligns with research conducted by [29], who found that social media is important in increasing pregnant women's awareness of maternal Health. They noted that pregnant women often use platforms such as Facebook, Instagram, and YouTube to seek information on healthy eating patterns and the risk of anemia. In their study, pregnant women who actively accessed health content on social media showed a better increase in understanding compared to those who only relied on routine medical consultations.

Telemedicine

Telemedicine emerged as the most powerful approach in supporting the improvement of nutritional literacy and anemia prevention in pregnant women compared to other digital education methods. Its advantage lies in the ability to provide direct and personalized health consultation services, which allows pregnant women to gain a more specific and relevant understanding of their health conditions. Real-time interaction between healthcare workers and patients provides a more in-depth and responsive educational dimension, which cannot always be achieved through social media or e-learning platforms.

In addition, telemedicine contributes greatly to overcoming geographical and accessibility barriers, especially for pregnant women who live in remote areas or have mobility limitations. This places telemedicine as a strategic solution in equitable access to information and health services, while supporting promotive and preventive efforts in the context of maternal health. Its significant effectiveness also suggests that this technology-based approach is worth considering in the formulation of public health policies and interventions, particularly those that focus on vulnerable groups such as pregnant women.

This finding is consistent with previous studies highlighting the effectiveness of telemedicine in maternal health education. The study by [30] found that telemedicine increased access to maternal health services and significantly increased pregnant women's understanding of balanced Nutrition. They found that pregnant women who used telemedicine were likelier to follow healthy diet recommendations than those who only relied on social media or e-learning-based education.

CONCLUSION

The use of health education technology has been proven to be effective and significant in improving nutritional literacy and preventing anemia in pregnant women, with telemedicine showing the strongest influence. Digital-based approaches such as mobile apps, e-learning, and social media also contribute positively, albeit with varying levels of effectiveness.

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