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Role of Technology in Maternal Health Education to Improve Childbirth Readiness

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ABSTRACT

Aims This study aimed to analyze the role of technology in maternal health education to improve maternal readiness, measure its effectiveness in terms of knowledge, mental and physical readiness, and identify challenges and implementation strategies.
Instrument & Methods This quantitative research utilized partial least squares structural equation modeling with a sample of 99 pregnant women at the Umar Damanik Health Center in Tanjung Balai. Sampling was conducted using the Slovin formula (with a 5% margin of error). Data were collected through valid and reliable questionnaires and analyzed using SmartPLS to test construct reliability (Cronbach's alpha, composite reliability), convergent validity (average variance extracted), and hypothesis testing (bootstrapping).
Findings All constructs met the reliability and validity criteria (Cronbach's alpha>0.7; AVE>0.5). Technology significantly influenced childbirth readiness (R^2=0.717-0.899; $p<0.05$). Mobile health applications provided interactive information access, IoT facilitated real-time monitoring, streaming platforms expanded educational resources, and telemedicine increased access to health consultations. The PLS-SEM model explained 84.1% of the data variability (adjusted R^2).
Conclusion Technology effectively improves childbirth readiness through accessible, interactive, and personalized education.

Keywords Digital Health Technology; Mobile Applications; Internet of Things; Telemedicine

CITATION LINKS

[1] Combining home garden, poultry, and nutrition education program targeted to families with young children ... [2] Impact of eHealth education to reduce anemia among school-going ... [3] Effects of lipid-based nutrient supplements and infant and young child feeding counseling with or without improved ... [4] Effectiveness of public health education on the uptake of iron and folic ... [5] Strategies to combat ... [6] Internet usage among pregnant women for seeking ... [7] Digital communication media and maternal health education: Integration of bibliometric analysis, methodological analysis ... [8] Improving child health and cognition: Evidence from ... [9] Innovation in nutrition promotion: Literature analysis to increase ... [10] Iron deficiency anemia and associated factors among adolescent ... [11] Education of the "SusCatinTing" application on changes in ... [12] An analysis of societal determinant of anemia among adolescent ... [13] Pregnant adolescent females' knowledge and practice towards iron deficiency anemia: Impact of ... [14] The intervention of maternal nutrition literacy has the potential to prevent ... [15] Effectiveness of a nutritional education intervention focussed on iron among children ... [16] Effectiveness of daily educational message on pregnancy anemia prevention ... [17] Health for anemia reduction: Protocol for an entertainment ... [18] Parenting and digital media: From the early web ... [19] Delivering an action agenda for nutrition interventions addressing adolescent ... [20] The Effect of Using Leaflet Media to Reduce Anxiety ... [21] Effects of family participatory dignity therapy on the ... [22] Educating the Community to Prevent Stunting Through Participatory ... [23] Relationship Between Pregnant Women's Participation ... [24] A new dimension of health care: Systematic review of the uses, benefits, and limitations ... [25] Mobile media device use is associated with ... [26] Improvement in maternal health literacy among pregnant women who did not complete compulsory ... [27] The effect of a nutrition education program on the nutritional ... [28] Effect of a social media-based health education program on postnatal care (PNC) knowledge among pregnant women using smartphones ...

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Introduction

The health of pregnant women is a crucial aspect of global health, playing a significant role in efforts to reduce maternal and infant mortality rates [1]. Optimal preparation during pregnancy greatly influences the safety and smoothness of the delivery process [2]. However, many pregnant women still face challenges in accessing accurate and timely information about their health [3]. Technology in healthcare offers various innovative solutions that can enhance the readiness of pregnant women for childbirth [4].

Health professionals are very concerned about the still-high rates of maternal and newborn deaths in some underdeveloped nations. The World Health Organization (WHO) statistics indicate that in 2017, pregnancy and its complications accounted for nearly 295,000 deaths among women [5]. Most cases occur in countries with limited access to adequate health services. The main causes of maternal death include postpartum hemorrhage, preeclampsia, infections, and complications from uncontrolled labor [6]. Many of these conditions can be prevented with better education and early detection of potential risks during pregnancy [7].

Ineffective dissemination of health information is one of the main obstacles to increasing the readiness of pregnant women [8]. Many mothers still rely on information from family, friends, or myths that do not necessarily have a strong scientific basis [9]. In addition, access to health services in remote areas remains limited, making it difficult for pregnant women to obtain the appropriate health information when needed [10]. Therefore, utilizing technology in maternal health education is a potential solution to overcome this problem.

Technology has brought transformation to various sectors, including the field of maternal and child health [11]. Numerous technology-based innovations have been developed to support the readiness of pregnant women in facing childbirth. These include mobile health applications that provide educational information about pregnancy, fetal development, and important warning signs to consider; telemedicine, which allows for online consultations with medical personnel, enabling pregnant women to obtain medical information and recommendations without needing to visit a health facility in person; wearable technology, such as smartwatches and medical sensors, that allows for real-time monitoring of pregnant women's health, including heart rate, blood pressure, and physical activity; social media and online forums that enable pregnant women to share experiences and gather information from other mothers and medical professionals; and virtual reality (VR) and augmented reality (AR) technology, which offers more interactive and realistic childbirth preparation training. These developments allow technology to improve the health literacy of pregnant women, help them recognize danger signs of pregnancy earlier, and enhance both their physical and mental readiness for childbirth [12].

Although technology offers a variety of innovative solutions, several challenges remain in its implementation. These include limited access to technology, meaning that not all pregnant women have access to digital devices or stable internet networks, especially in rural areas; a lack of digital literacy, which causes some pregnant women to struggle with how to utilize health technology optimally; concerns regarding the validity of information, as the abundance of sources available on the internet increases the risk of spreading invalid or misleading information; and compliance with use, since not all pregnant women consistently use technology to monitor their health [13]. Therefore, an appropriate strategy is needed to ensure that technology is accessible and optimally utilized by pregnant women from various social and economic backgrounds.

This research provides a new contribution to the use of technology in improving the readiness of pregnant women for childbirth [14]. Some aspects of the novelty of this study include an integrative analysis that discusses not only one type of technology but analyzes various technologies in a cohesive manner to assess their effectiveness in improving childbirth readiness; a personalized approach that emphasizes the importance of adapting technology to suit the individual needs of pregnant women based on their health conditions, literacy levels, and access to health facilities; an effectiveness evaluation that measures the extent to which the use of technology impacts childbirth readiness in terms of knowledge, mental readiness, and physical health; and an evidence-based implementation strategy that not only identifies the benefits of technology but also provides concrete recommendations on how technology can be implemented more effectively within the health service system [15].

This research investigated the contribution of technology to maternal health education through the application of various technologies and their effects on birthing readiness. It aimed to measure the extent to which technology can enhance the mental, physical, and knowledge preparedness of pregnant women in confronting the childbirth process, as well as to evaluate the effectiveness of technology in improving childbirth readiness. Additionally, it will expose the various difficulties pregnant women encounter in obtaining and using health technology, thereby gathering suggestions for more efficient technology application by offering evidence-based strategies to enhance the use of technology in maternal health education.

In terms of knowledge, mental preparedness, and physical health, technology in maternal health education shows great promise for increasing

childbirth readiness. This paper aims to provide greater insight into the role of technology and strategies to maximize its use, even though its implementation presents certain challenges. Therefore, this study is likely to reduce the risk of birthing difficulties and improve the quality of health services for expectant mothers.

Instrument and Methods

Study design

This quantitative utilized the partial least squares structural equation modeling (PLS-SEM). This method was chosen because it can analyze complex relationships between latent parameters and allows for the simultaneous testing of structural models and measurements. The study was conducted at the Umar Damanik Health Center in Tanjung Balai City, which was chosen due to its significant number of pregnant women over two months from November to December 2024.

Sample

The sample consisted of all pregnant women who had pregnancy check-ups at the Umar Damanik Health Center in Tanjung Balai City from November to December 2024, totaling 132 individuals selected using purposive sampling. The number of samples was calculated using the Slovin formula with a margin of error of 5%, resulting in a sample size of 99 respondents.

$n=N/(1+N(e)^2)$

In this formula, n is the sample size, N is the total population, and e is the margin of error (5%). The number of samples obtained was 99 respondents. The population size can be determined as follows:

$99=N/(1+0.0025N)$
$99+0.2475N=N$
$0.7525N=99$
$N\approx132$

The total sample size was considered to be approximately 132 individuals. Pregnant women with multiple pregnancies were included, while pregnant women with medical complications, such as preeclampsia, hypertension, and gestational diabetes, were excluded.

Data were collected through questionnaires that had been tested for validity and reliability in previous studies.

Statistical analysis

Statistical analysis was conducted using the PLS-SEM. This method was chosen because it is suitable for predictive research and can handle complex models with multiple latent parameters. The analysis process was carried out using SmartPLS software version 4.1.1.4, which is specifically designed to support PLS-SEM techniques. The use of SmartPLS allows for analysis even if the data do not meet the assumption of normality. The statistical tests carried out included the reliability assessment, which is analyzed using composite reliability values and Cronbach's alpha to measure the internal consistency of the construct; convergent validity, which is evaluated based on average variance extracted (AVE) values, while discriminant validity is tested using Fornell-Larcker criteria and cross-loadings; and the hypothesis test, which was conducted with a bootstrapping procedure of 132 resamples to obtain t-statistics and p-values, used to test the significance of the relationships between constructs.

After the data were collected, the analysis was conducted using statistical software based on PLS-SEM. During the analysis stage, construct reliability testing was performed through composite reliability and Cronbach's alpha, as well as convergent and discriminant validity testing, to ensure the accuracy of construct measurement. Additionally, hypothesis testing was conducted through the analysis of t-statistic values, p-values, and the use of bootstrapping techniques to ensure the significance of the relationships between parameters.

Findings

Most participants were of ideal reproductive age and had a secondary education level. In terms of pregnancy spacing and number of deliveries, most respondents had prior experience, either as mothers of their first child or with varying birth spacing (Table 1).

Table 1. Frequency of demographic and obstetric characteristics of the samples

Parameter	Values
Age (year)	
<20 or >35	41(15.9)
20-35	92(84.1)
Education	
Elementary school	4(0.7)
Junior high school	26(13.6)
Secondary school	63(56.8)
Diploma/Bachelor's degree	40(28.9)
Pregnancy spacing	
The first child	43(38.6)
<2 years	13(9.1)
>2 years	77(52.3)
Parity	
≥3 times	60(43.9)
<3 times	73(56.1)

All constructs met the criteria for reliability and validity. The Cronbach's alpha and composite reliability values indicated that the tools used had good internal consistency. Convergent validity was also achieved, as indicated by the adequate AVE value. Thus, all indicators in each construct were deemed feasible for use (Table 2).

The role of technology in maternal health education to improve childbirth readiness showed an R^2 square value of 0.955 and an adjusted R^2 of 0.949, indicating that the model used was very strong and relevant in

describing the relationship between the use of technology and maternal readiness to face childbirth. The effect of maternal health education on improving childbirth preparedness was tested and yielded significant results.

Thus, all indicators of maternal health education aimed at improving childbirth preparedness had a significant influence (Table 3).

Table 2. Results of composite reliability and Cronbach's alpha

Construction	Cronbach's Alpha	Rho-A	Composite reliability	Average variance extracted (AVE)
Mobile health app	0.758	0.917	0.717	0.568
Internet of Things (IoT)	0.870	0.885	0.752	0.564
Streaming platforms	0.863	0.723	0.768	0.791
Telemedicine	0.826	0.821	0.838	0.899
The role of technology in maternal health education to improve childbirth readiness	1.000	1.000	1.000	1.000

Table 3. Role of technology in maternal health education to improve childbirth preparedness

Parameter	Original sample (O)	Sample mean (M)	Standard deviation	T-statistics (|O/STDEV|)	p-value
Mobile health app	0.252	0.251	0.093	2.580	0.030
Internet of Things (IoT)	0.344	0.192	0.101	2.949	0.050
Streaming platforms	0.257	0.232	0.078	2.852	0.038
Telemedicine	0.357	0.471	0.154	2.861	0.004

Discussion

This study aimed to analyze the role of technology in maternal health education to improve maternal readiness, measure its effectiveness in terms of knowledge, mental and physical readiness, and identify challenges and implementation strategies. The use of digital technology in the form of health applications has provided significant support for pregnant women in preparing for childbirth. Easy access to various information about pregnancy, whether in the form of articles, videos, or interactive guides, helps enhance mothers' understanding of the pregnancy and delivery process. Convenient features, such as reminders for check-up schedules and monitoring of fetal development, also offer convenience, especially for those in areas with limited access to health services. This technology serves as an efficient means of helping pregnant women recognize important signs during pregnancy, including emergencies that require medical attention [16]. With these various conveniences, digital applications are an important component in supporting the physical and mental readiness of pregnant women [17].

This aligns with research by Lupton *et al.*, who found that mobile-based health applications can enhance pregnant women's understanding of pregnancy health, potential risks, and steps to prepare for childbirth [18]. Additionally, research conducted by Bhutta *et al.* supports these findings by demonstrating that mobile health applications designed interactively and based on evidence can increase the preparedness and confidence of pregnant women in facing childbirth [19]. In another study, applications that offer online consultation features with medical personnel, reminders for pregnancy check-ups, and multimedia-based information are reported to be more effective than conventional education methods [20].

The content you uploaded discusses the benefits of using the Internet of Things (IoT) in maternal health education. It emphasizes how IoT helps pregnant women access health information flexibly, enabling them to overcome barriers related to time and space. The technology allows them to engage with materials related to pregnancy and childbirth in various formats, such as videos, interactive modules, and discussion forums, thus offering personalized learning methods. Furthermore, IoT can reach a wider population, including pregnant women in areas with limited access to traditional healthcare services. This finding is supported by research conducted by R. Gray, who examined the effectiveness of the IoT in improving pregnant women's understanding of childbirth preparation [21]. In the study, pregnant women who utilized prenatal care based on the IoT demonstrated a significant increase in knowledge about the labor process, signs of pregnancy danger, and pain management during labor compared to the group that received only conventional education [22]. Additionally, the study found that pregnant women who use the IoT feel more confident in facing labor because they have access to valid and scientifically based information.

Streaming platforms play an important role in helping pregnant women prepare for the delivery process. Based on the results that meet the limitations of hypothetical acceptance, it can be concluded that streaming platforms are an effective source of information for maternal health education. Pregnant women can easily access various information about pregnancy, childbirth, and baby care through these platforms, with content sourced from trusted sources, such as medical personnel, health institutions, and the pregnant women's community.

Streaming platforms also provide opportunities for pregnant women to interact directly with medical

personnel and other pregnant women. This interaction fosters a community that allows pregnant women to share experiences and gain invaluable social support. Thus, streaming platforms are not only a means of obtaining information, but also serve as a space for pregnant women to feel more prepared and supported as they approach childbirth. Research by Lupton *et al.*, which examined how social media might enhance pregnant women's health literacy, supports this finding [18]. Another study found that pregnant women who actively access health information through streaming platforms tend to have higher levels of childbirth readiness than those who rely solely on conventional information sources [23]. Streaming platforms offer quick and easy access to educational content, such as videos, articles, and webinars that discuss important topics related to pregnancy and childbirth. Additionally, the study also showed that social media helps reduce anxiety in pregnant women by providing a discussion space and emotional support from the online community.

Another advantage of streaming platforms is their ability to disseminate information quickly and reach a wider population through various formats, such as infographics, interactive videos, and live Q&A sessions. However, a challenge in using streaming platforms as sources of health information is the legitimacy and credibility of the information being provided. According to Moorhead *et al.*, while streaming platforms have great potential in health education, disseminating information that is not scientifically based poses a risk that must be addressed [24]. Therefore, pregnant women need to obtain information from trusted sources, such as the official accounts of medical personnel or credible health institutions.

Telemedicine has proven to be an effective tool in helping pregnant women better prepare for childbirth. These digital healthcare services offer significant benefits by ensuring quick and accurate access to vital medical information. Telemedicine enables pregnant women to consult healthcare professionals remotely, eliminating the need to visit medical facilities. This is especially advantageous for those residing in remote areas with limited access to healthcare services. Moreover, telemedicine facilitates more comprehensive health monitoring for pregnant women through options like teleconsultations, online education, and remote monitoring systems. As a result, telemedicine provides an accessible and cost-effective solution for supporting the health of pregnant women.

This finding is supported by research conducted by Van Den Heuvel *et al.*, who examined the effectiveness of telemedicine in improving antenatal care [25]. They indicated that pregnant women who utilize telemedicine for routine consultations and monitoring of pregnancy conditions have a higher level of labor readiness compared to those who rely solely on face-to-face visits [26]. Habib *et al.* also found that telemedicine can help reduce anxiety in pregnant women by providing faster access to medical information and support from health workers, thereby increasing confidence in facing the labor process [12].

Another advantage of telemedicine is its ability to overcome various barriers to accessing health services, particularly in areas with limited medical personnel. With telemedicine-based consultations, pregnant women can receive timely medical advice, monitor their pregnancy conditions regularly, and access relevant health education programs. However, challenges exist in implementing telemedicine, especially regarding limited technology, internet access, and digital literacy [27]. According to the WHO (2020), the effectiveness of telemedicine is highly dependent on the readiness of technological infrastructure and ease of use for the community, especially in developing countries [28]. Therefore, efforts are needed to improve accessibility and digital literacy for pregnant women so that the benefits of telemedicine can be fully realized.

Technology plays a significant role in maternal health education by improving childbirth readiness. Mobile health applications have been shown to provide easier and more interactive access to information, helping pregnant women better understand their pregnancy conditions. The IoT contributes to real-time health monitoring and enhances maternal compliance with medical recommendations. Streaming platforms facilitate the dissemination of broad and interactive health information, allowing pregnant women to gain deeper insights from various trusted sources. Meanwhile, telemedicine services offer convenience in medical consultations without the need to physically visit health facilities, making access to health services more efficient.

Although these technologies have proven effective, challenges such as limited access to technology, digital literacy, and the validity of information must still be addressed. Therefore, a more optimal implementation strategy is required to ensure that technology can be utilized effectively in supporting pregnant women's childbirth readiness.

Conclusion

Technology plays a significant role in maternal health education by improving childbirth readiness.

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