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The Impact of WhatsApp Chatbot-Based Educational Intervention on Nutritional Literacy of Pregnant Women: A Quasi-Experimental Study in the Cot Seumeureng Community Health Center Work Area

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ABSTRACT

Ensuring optimal nutritional intake during pregnancy is fundamental to supporting healthy fetal growth and development. Consequently, enhancing the nutritional literacy of pregnant women is a critical public health objective to prevent adverse outcomes such as stunting and maternal anemia. This study aimed to evaluate the efficacy of a WhatsApp chatbot-based educational intervention in improving pregnant women's nutritional literacy. A quasi-experimental study with a pre-post test control-group design was conducted at the Cot Seumeureng Community Health Center in West Aceh. Using purposive sampling, 84 pregnant women were enrolled and divided into an intervention group (n=42) and a control group (n=42). The intervention group received structured nutrition education delivered via a WhatsApp chatbot over a four-week period, whereas the control group received standard antenatal services. Data were collected using a modified and validated Nutrition Literacy Assessment Instrument for Pregnant Women (NLAI-P) and analyzed using Paired and Independent Sample T-Tests. The findings indicated a substantial increase in the mean nutritional literacy scores of the intervention group, rising from 12.05 to 19.19. In contrast, the control group's scores remained relatively stagnant, moving from 13.05 to 13.33. The Independent Sample T-Test confirmed a statistically significant difference in post-test outcomes between the two groups (t=−7.626;p=0.000), demonstrating the superior impact of the digital intervention. A WhatsApp chatbot-based educational intervention is a highly effective, accessible, and innovative modality for significantly enhancing maternal nutritional literacy.

Key Messages:

- WhatsApp chatbot-based nutritional education interventions have proven significantly effective in enhancing maternal nutritional literacy, providing an innovative, interactive, and highly accessible digital modality to strengthen maternal health programs and support the prevention of nutritional issues such as stunting.

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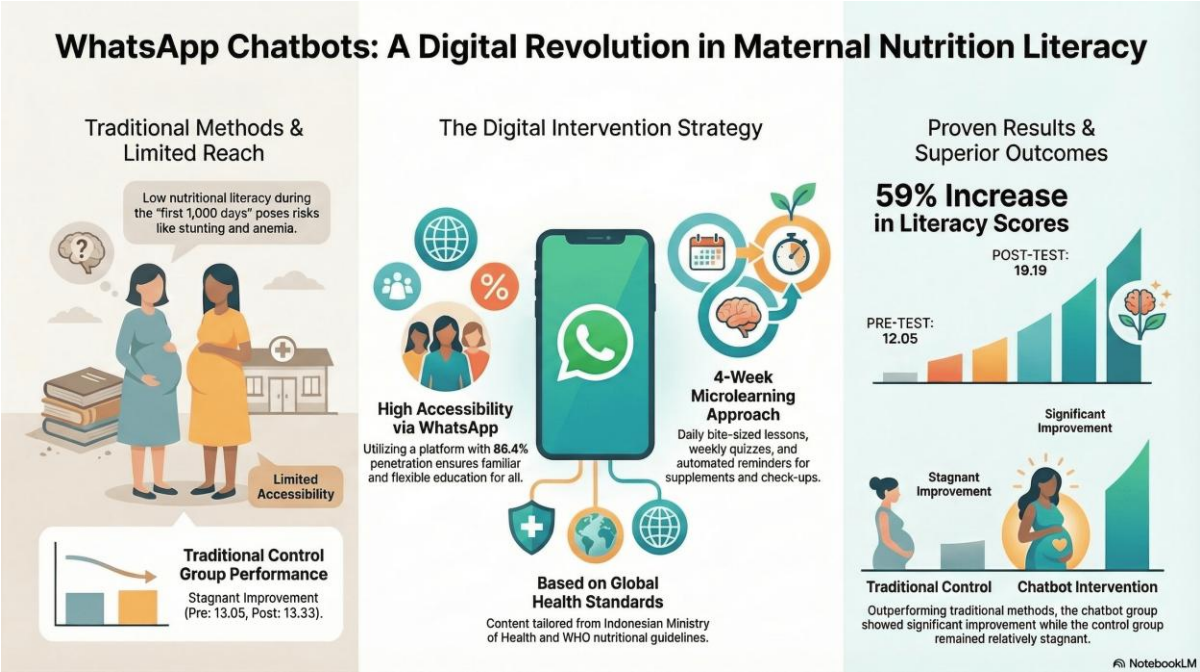
GRAPHICAL ABSTRACT



INTRODUCTION

The first 1,000 days of life begin from pregnancy until the child is two years old, so the quality of nutrition and maternal health during pregnancy are the main foundation for child growth and development (1,2). Malnutrition in pregnant women can cause various negative consequences, such as anemia (3), low birth weight (LBW) (4), premature birth, and even stunting in children later in life (5,6). On the other hand, optimal nutritional fulfillment during pregnancy has been proven to contribute greatly to supporting maximum child growth and development (7,8).

The growth of the fetus in the womb completely depends on the condition of the mother carrying it. Good health and nutritional status of the mother is very necessary so that the fetus can grow and develop normally. Therefore, pregnant women must fulfill their nutritional needs, both for themselves and for their fetus. In addition to the macronutrients needed daily, there are also micronutrients that are very important for fetal growth and development, such as protein, folic acid, iron, iodine, and calcium. These micronutrients are needed in greater amounts during pregnancy than under normal conditions (9).

However, meeting these nutritional needs is often hampered by pregnant women's limited knowledge of nutrition. Low nutritional literacy can lead to inappropriate consumption patterns, negatively impacting maternal health and fetal growth and development (10,11)

Therefore, it is necessary to improve the nutritional literacy of pregnant women (5). Nutritional literacy is the ability of individuals to obtain, process, and understand basic information about nutrition needed to make appropriate health decisions (12). Increasing the nutritional literacy of pregnant women has been shown to contribute to decisions about healthy food consumption, iron and folic acid supplementation (13,14)and increased compliance with antenatal care visits (15).

So far, improving nutritional literacy for pregnant women has relied on conventional methods, such as face-to-face individual and group counseling. However, this method faces various obstacles, including limited health workers, high workloads, and limited funding. Therefore, a new approach is needed that is more effective, efficient, and accessible (16,17)

In the digital era, the use of WhatsApp chatbots based on rules and artificial intelligence has become an innovative alternative (18). WhatsApp has a high penetration rate of 86.4% in Indonesia in 2023 (19), suggesting it could serve as a means of health education, including for pregnant women, given its widespread use. The selection of WhatsApp as an educational medium in this study was based on several

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considerations. First, in terms of accessibility, WhatsApp can be used by pregnant women with smartphones anytime, anywhere, even in areas with limited internet connectivity, allowing for flexible delivery of ongoing education. Second, in terms of familiarity, many pregnant women and their families already use WhatsApp for daily communication, so barriers to using new media can be minimized. Third, in terms of interactivity, WhatsApp can send structured messages, reminders, and quizzes, making it suitable for micro-learning and iterative education approaches to strengthen nutritional literacy (20).

The chatbot developed in this study was designed based on official guidelines from the Indonesian Ministry of Health and WHO, using a microlearning approach in the form of daily material with communicative language and tailored to the user's level of understanding (21,22). In addition to conveying information, the chatbot is also equipped with interactive features such as automatic responses to certain keywords, weekly quizzes to strengthen information retention, and personalized notifications, such as reminders for Antenatal Care (ANC) schedules and consumption of pregnancy supplements (23,24). This digital approach not only increases the understanding and involvement of pregnant women in healthy nutritional behaviors, but also reduces the burden on health workers, increases the efficiency of health promotion, and supports earlier and sustainable stunting prevention (17,25).

Several previous studies have shown the great potential of using chatbots and digital interventions in health education. Research conducted by Montenegro, Costa, and Souza (25) developed a conversational agent for pregnancy nutrition education and tested it on 25 pregnant women and 10 health workers. The results showed positive perceptions, with pregnant women rating the agent as effective in conveying new knowledge during the prenatal period. Furthermore, research by Amil et al. (26) A study summarizing 12 studies from various countries on the use of chatbots from preconception to 12 months postpartum reported that chatbots can improve user satisfaction, knowledge, and health behavior, as well as facilitate access to information and interaction with health workers. This digital intervention was even found to be more effective than face-to-face counseling. Meanwhile, a study by Lee et al. (27) evaluated the effectiveness of mHealth interventions on maternal, newborn, and child health in low- and middle-income countries. Of the 17 studies analyzed, SMS-based interventions were shown to improve breastfeeding practices within the first hour after birth and exclusive breastfeeding, although only a few showed a significant impact on morbidity and mortality. This underscores the need for further research with more robust methodological designs. In addition, the study by Bi et al. (28) Systematic reviews and meta-analyses showed that digital health interventions improved healthy behaviors, such as increasing daily steps, although not all aspects of physical activity showed significant differences.

Based on this description, chatbots have great potential to improve nutritional literacy and encourage healthy lifestyles among pregnant women. While previous international research has demonstrated the effectiveness of chatbots in improving health literacy, this study provides a novel contribution by adapting the WhatsApp chatbot-based educational intervention to the socio-cultural context of pregnant women in Indonesia and referring to the balanced nutrition guidelines from the Indonesian Ministry of Health, which have not been widely explored in previous research. Given that the use of digital media for WhatsApp chatbot-based nutrition education in Indonesia remains very limited, this study hypothesizes that pregnant women who receive a 4-week WhatsApp chatbot-based nutrition education intervention will show a greater increase in nutritional literacy scores than those who do not.

METHODS

This study is a quantitative study with a quasi-experimental pre-post test with control group design, involving two groups, namely the intervention group and the control group. This design was used to assess the effectiveness of digital-based nutrition education via WhatsApp chatbot on improving nutritional literacy in pregnant women (29). The research variables consist of independent variables and dependent variables. The independent variable is digital-based nutrition education, while the dependent variable is nutritional literacy of pregnant women. This study was conducted in the Cot Seumereng Community Health Center Working Area, West Aceh with a population of all pregnant women in the first, second, and third trimesters totaling 316 people. The number of samples was determined using G * Power 3.1 software with a one-tailed test, effect size 0.8 , and a significance level of 0.05. Based on 95% power,

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and considering a 20% dropout for reasons such as there being pregnant women who experienced pregnancy complications, were less cooperative, or respondents gave birth during the study. The study sample was obtained as many as 84 respondents, which were divided into two groups: intervention (42 respondents) and control (42 respondents). The sampling technique used was purposive sampling, with the criteria of respondents having an Android smartphone and the WhatsApp application, and being able to operate it, being able to read and write, being cooperative and able to communicate fluently, understanding Indonesian language instructions, and being willing to participate in the study (30,31).

The research data consists of primary and secondary data. Primary data were collected directly from respondents by measuring nutritional literacy before and after the intervention in both groups. Meanwhile, secondary data is collected through documentation studies from various relevant sources to support the analysis and interpretation of research results.

The nutrition education intervention medium in this study used a WhatsApp chatbot. The chatbot was developed by the research team in collaboration with Information and Communication Technology (ICT) experts and designed to educate pregnant women about nutrition, presenting information in an interactive, structured, and easily accessible manner. Respondents registered through the WhatsApp application installed on their mobile phones to connect to the chatbot system. During the intervention, the chatbot delivered pregnancy nutrition education materials using a microlearning approach, consisting of brief information, quizzes, and daily reminders such as taking iron tablets and ANC check-ups.

The educational material presented is based on the guidelines of the Indonesian Ministry of Health and WHO, and is adapted to the literacy level of pregnant women so that it is easy to understand and communicative. Nutrition literacy measurements are carried out using the Nutrition Literacy Assessment Instrument for Pregnant Women (NLAI-P) (32) , modified by the researcher to adapt to the local Indonesian language and cultural context. Validity tests showed all items had an r value > 0.361, while reliability tests yielded a Cronbach's alpha value of 0.906, indicating a good level of internal consistency. Data collection was conducted twice for each group: a pre-test and a post-test. The control group did not receive educational intervention via WhatsApp chatbot, but still received standard services from the community health center, such as prenatal checkups and routine nutrition counseling according to the antenatal care (ANC) schedule or during integrated health post (Posyandu) activities. The intervention group received structured nutrition education via WhatsApp chatbot for four weeks. The chatbot sent daily educational messages containing short microlearning materials, weekly quizzes, and reminders to take pregnancy supplements. Educational topics are structured in stages, covering the nutritional needs of pregnant women (week 1), macro and micronutrients (week 2), antenatal check-ups and pregnancy supplements (week 3), and anemia and stunting prevention (week 4).

Data analysis was performed using Paired Sample T-Test and Independent Sample T-Test. which previously carried out prerequisite tests, namely normality and homogeneity tests. Paired Sample T-Test to determine the increase in nutritional literacy of pregnant women before (pretest) and after (posttest) in each group. Meanwhile, the Independent Sample T-Test was used to see whether there was a significant influence of the use of the WhatsApp chatbot application on the nutritional literacy of pregnant women by comparing the intervention group and the control group.

CODE OF HEALTH ETHICS

This study involved human respondents; therefore, ethical procedures were applied even though no harmful impact was expected. The procedures were reviewed and approved by the Health Research Ethics Committee, with ethical clearance certificate Number: 030/LRPM/EC-IN/VIII/2025.

RESULTS

Respondent Characteristics

Most respondents in both the intervention and control groups were in early adulthood (26-35 years). The highest educational level of respondents in both the intervention and control groups was mostly secondary education. Some respondents in the intervention and control groups were unemployed. The gestational age of respondents in the intervention group and control group was the second trimester (table

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1).

Table 1. Respondent Characteristics

Respondent Characteristics	Control group		Intervention group	
	n	%	n	%
Age				
Late Adolescence (17-25 Years)	14	33.3	12	28.6
Early Adulthood (26-35 Years)	21	50	24	57.1
Late Adulthood (36-45 Years)	7	17.7	6	14.3
Education				
basic education	6	14.3	7	16.7
Secondary Education	31	73.8	26	61.9
higher education	5	11.9	9	21.4
Work				
Doesn't work	39	92.9	37	88.1
Work	3	7.1	5	11.9
Gestational Age				
Trimester 1	9	21.4	7	16.7
Trimester 2	23	54.8	27	64.3
Trimester 3	10	23.8	8	19.0

Table 2. Results of Paired Sample T-Test on Nutritional Literacy Scores of Pregnant Women in the Control and Intervention Groups

Group	Mean ± SD	t	df	Sig. (2-tailed)
Control Group				
pretest	13.05 ± 3.98	-3.106	41	0.003
post-test	13.33 ± 4.30			
Intervention Group				
pretest	12.05 ± 2.88	-18,632	41	0.000
post-test	19.19 ± 2.51			

In the control group, the nutritional literacy score of pregnant women increased from the pretest mean of 13.05 ± 3.98 to 13.33 ± 4.30 in the posttest. The results of the paired-samples t-test showed a p-value of 0.003 ($p < 0.05$), indicating a significant difference between the pretest and posttest scores. However, the increase in the mean was relatively small, so changes in nutritional literacy in the control group did not reach statistical significance. In contrast, in the intervention group, there was a greater increase in nutritional literacy scores from the pretest mean of 12.05 ± 2.88 to 19.19 ± 2.51 in the posttest. The results of the paired sample T-test showed a p-value of 0.000 ($p < 0.05$), indicating a significant difference between the pretest and posttest scores in the intervention group. Thus, the higher mean increase in the intervention group than in the control group indicates that the WhatsApp chatbot-based nutrition education intervention significantly increased pregnant women's nutritional literacy.

Table 3. Results of the Independent Sample T-Test on Nutrition Literacy Scores between the Intervention and Control Groups

Group	n	Mean	Standard Deviation (SD)	t	df	Sig. (2-tailed)
Control	42	13.33	4.298	-7.626	66.067	0.000
Intervention	42	19.19	2.511			

Based on the independent-samples t-test, there was a significant difference in the average post-test scores between the control and intervention groups ($p < 0.05$) (Table 3). This means that the Independent Sample T-Test results showed a significant difference in post-test nutritional literacy scores between the control and intervention groups ($t = -7.626$; $p = 0.000$). The average nutritional literacy score in the intervention group (Mean = 19.19; standard deviation (SD) = 2.511) was higher than the control group (Mean = 13.33; SD = 4.298). This indicates that digital nutrition education via WhatsApp Chatbot is effective in increasing pregnant women's nutritional knowledge, compared to the control group that did not receive the intervention.

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DISCUSSION

The study results showed that digital-based nutrition education interventions using a WhatsApp chatbot were effective in improving nutritional literacy among pregnant women compared to the control group. The increase in nutritional literacy scores in the intervention group was significantly higher than in the control group, demonstrating that delivering education through interactive digital media can be an innovative alternative to improving nutritional literacy among pregnant women.

The increase in literacy scores in the intervention group indicates that using a WhatsApp chatbot provides a more effective learning experience than conventional education. The chatbot delivers information in a structured, interactive, and accessible manner, improving respondents' understanding of nutrition during pregnancy. The chatbot's ability to provide automated responses and immediate feedback encourages active user participation, strengthens knowledge retention, and increases motivation to learn. This aligns with modern health literacy theory, which holds that health literacy encompasses not only the ability to read and write but also to access, understand, assess, and apply health information for informed decision-making. In the context of pregnancy, this literacy is known as maternal health literacy, which refers to the ability of pregnant women to obtain and utilize relevant information to support their pregnancy care and nutritional status (33,34).

Meanwhile, the small but significant increase in the control group could be due to several factors. Pregnant women in this group continued to receive basic information from health workers at integrated health posts (Posyandu) and other health care facilities, as well as from the media and their surrounding environment. Completing the pretest questionnaire may also have increased initial awareness of the importance of nutrition during pregnancy, encouraging them to seek additional information from other sources. The Hawthorne effect is an increase in attention to behavior due to awareness of being studied. However, the increase was relatively small and did not indicate a practically meaningful change compared to the intervention group.

Chatbots serve as a technological innovation that integrates elements of modern health literacy, including ease of access, understanding, assessment, and application of information in decision-making (35). The use of a WhatsApp chatbot in this study can be seen as a simple application of artificial intelligence (AI) designed to improve nutritional literacy among pregnant women. The chatbot acts as a digital agent that not only conveys information but also facilitates interaction, clarification, and strengthening of respondents' understanding in accordance with the principles of modern health literacy (36). In the context of pregnancy, chatbots not only convey nutritional information in a structured and interactive manner but are also able to adapt to the specific needs of pregnant women through personalization features. Recent research, such as the development of the BiGRU-based GyBot, shows that chatbots designed with bilingual and context-aware systems can improve response accuracy in obstetric care, thus strengthening their potential use in various clinical and community settings (37).

The results of this study are also supported by chatbot-based digital nutrition interventions, such as the TreC_Mamma project, which is designed to support a healthy pregnancy. This intervention is designed to be personalized by considering various dietary patterns, such as the Mediterranean, vegetarian, and vegan diets, so that it can be tailored to each individual's specific nutritional needs and has been shown to increase the effectiveness of nutrition education for pregnant women (38).

Findings. This is consistent with the literature, which shows that intervention-based chatbots are effective in increasing knowledge and improving behavioral health in women. Review systematic and meta-analyses from ten studies, experiments conducted from 2019 to 2023, reporting that chatbots can have a positive impact on the cognitive, psychological, and behavioral health of women, including in the context of pre-pregnancy, pregnancy, reproductive health, and psychological support. This confirms that digital media is based on chatbot can become a tool for effective education and efficient in increasing health, cognitive And physique Woman (39).

This research aligns with the study "Chatbots Be Nutritionists: Exploring the Potential of AI-Powered Tools to Improve Nutritional Counselling in Indonesia," which emphasized that chatbots have significant potential in providing personalized nutrition counselling tailored to users' needs. This is crucial given the differences in sociocultural conditions and varying levels of nutritional literacy within the

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community. Chatbots can bridge the gap between healthcare professionals and provide easy-to-understand information, thus supporting efforts to reduce the risk of stunting. Furthermore, research on the development of chatbots in Posyandu applications using the decision tree method also reported that users, both pregnant women and healthcare professionals, welcomed the presence of chatbots due to their ease of access, interactivity, and the relevance of the material presented (40).

Based on these findings, researchers assume that digital-based nutrition education through a WhatsApp chatbot is an effective and innovative strategy for improving nutritional literacy among pregnant women in Indonesia. The high accessibility, interactivity of the messages, and relevance of the material provided make this intervention effective in reaching a wider target audience, including pregnant women in areas with limited health services. The improvement in nutritional literacy achieved indicates that instant messaging-based digital media plays a significant role in strengthening pregnant women's understanding of nutrition during pregnancy. However, this increase in nutritional literacy does not necessarily result in changes in consumption behavior or nutritional status. Therefore, continued support and further research are needed to assess the long-term impact of behavioral changes and the application of nutritional knowledge in daily life. This study has several limitations: first, the implementation of the educational intervention through a WhatsApp chatbot was conducted in a single area, so the results cannot be broadly generalized. Second, the relatively short duration of the intervention does not reflect the long-term impact on changes in nutritional behavior among pregnant women. Third, the chatbot used was still rule-based, thus having limitations in answering complex questions. Furthermore, the effectiveness of the intervention was also influenced by external factors such as internet connection stability and the level of respondent participation during the study.

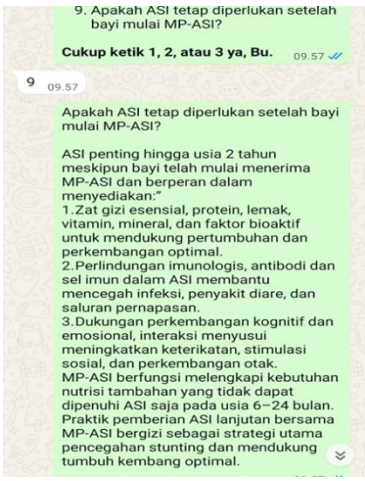

Figure 1. Example of a conversation about nutrition education for pregnant women on a WhatsApp chatbot

The image above shows an example of a conversation between a user (pregnant woman) and an educational chatbot. This chatbot provides automated responses to user questions based on pre-programmed educational material.

CONCLUSION

This study demonstrates that a digital nutrition education intervention delivered via a WhatsApp chatbot is highly effective at enhancing pregnant women's nutritional literacy. Empirical analysis using the Independent-Samples T-Test confirmed a statistically significant difference in post-test scores between the groups ($t = -7.626$; $p = 0.000$), with the intervention group achieving a substantially higher mean score (19.19) than the control group (13.33).

These findings suggest that WhatsApp chatbots serve as an innovative, accessible, and relevant educational modality to bolster maternal and child health programs in Indonesia. Furthermore, the strategic integration of this digital technology into routine antenatal care services at community health centers (Puskesmas) represents a sustainable approach to improving maternal health outcomes and

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advancing national public health digitalization policies.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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