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AI-powered whatsapp chatbots for maternal and child health: a quasi-experimental study among pregnant women in Indonesia

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ABSTRACT

Maternal and child health remains a critical priority in global health strategies, particularly in achieving the Sustainable Development Goals (SDGs). In Indonesia, maternal mortality remains significantly higher than the SDG target, underscoring the urgent need for accessible and high-quality maternal health information. Digital innovations, such as Artificial Intelligence (AI)-based chatbots, have emerged as promising tools to help bridge this gap. This study aimed to evaluate the effectiveness of a Meta-AI chatbot delivered via WhatsApp in improving pregnant women's access to maternal and child health information. A quasi-experimental one-group pretest–posttest design was employed, involving 30 pregnant women in Singasari Village, Tasikmalaya Regency. Participants received a one-time training session on accessing health information—particularly related to pregnancy care—through the Meta-AI WhatsApp chatbot, supported by a guidance booklet. Data were collected using a validated and reliable questionnaire that assessed participants' knowledge and skills before and after the intervention. Paired sample t-tests were used to compare pre- and post-intervention scores. The results demonstrated significant improvements in both knowledge and skills. Knowledge scores increased from 5.00 (SD = 2.00) to 9.40 (SD = 0.85), t-test (29) = 29.0, $p < 0.001$, Cohen's d = 1.88, 95% CI [1.27, 2.47]. Similarly, skills scores rose from 26.5 (SD = 5.40) to 36.7 (SD = 3.02), t-test (29) = 29.0, $p < 0.001$, Cohen's d = 2.31, 95% CI [1.61, 2.99]. These findings indicate that the Meta-AI chatbot, used via WhatsApp, significantly enhanced pregnant women's knowledge and skills, thereby improving access to accurate maternal health information, strengthening health literacy, and supporting informed decision-making. Future research should explore the long-term effects of this intervention and its potential integration into public health systems.

1. Introduction

Maternal and child health remains a central focus of global health initiatives, particularly in achieving the Sustainable Development Goals (SDGs), which aim to reduce maternal and infant mortality worldwide [1, 2]. In Indonesia, the maternal mortality ratio decreased from approximately 305 per 100,000 live births in 2015 to 189 per 100,000 live births in 2020. However, this figure remains substantially higher than the SDG target of ≤70 per 100,000 live births by 2030. The most recent estimates from the World Health Organization (WHO) indicate that Indonesia's maternal mortality ratio was approximately 173 per 100,000 live births in 2023, underscoring persistent

challenges in maternal health service delivery, particularly concerning the accessibility and utilization of maternal health information [3–6]. Limited access to accurate and timely information has been shown to constrain pregnant women's ability to recognize maternal health risks and make informed decisions [7]. A survey conducted at the Kedokteran Indonesia Kiara Clinic in DKI Jakarta revealed that only 24.7% of respondents demonstrated high health literacy, while 72.6% exhibited low health literacy levels [8]. Geographic isolation, socioeconomic disparities, and restricted digital access further exacerbate these inequalities [9]. Therefore, innovative strategies are needed not only to improve accessibility but also to enhance the quality of maternal and child health information [10].

Advances in digital health provide opportunities to address these barriers. Artificial Intelligence (AI)-based platforms have emerged as promising tools to expand the reach and availability of health information [11–13]. AI-driven chatbots serve as interactive conversational agents that enable rapid, personalized, and evidence-based information exchange [14]. Previous studies have demonstrated the effectiveness of chatbots as virtual health assistants capable of delivering interactive health education [15]. However, the novelty of this study lies in its application of Meta-Artificial Intelligence (Meta-AI) chatbots, which go beyond conventional AI chatbots by leveraging more advanced Natural Language Processing (NLP), contextual understanding, and adaptive responses tailored dynamically to the needs of pregnant women [16]. Consequently, Meta-AI chatbots not only provide one-way information but also facilitate more natural, contextual, and personalized interactions, thereby enhancing comprehension and user experience compared to traditional chatbots.

Prior research has documented the potential of AI chatbots to support evidence-based decision-making, increase pregnant women's confidence in utilizing maternal health services, and reduce barriers to maternal healthcare, particularly for women living in rural settings and low-income communities [17–19]. Despite the promising role of digital health interventions, empirical evidence regarding the implementation of Meta-AI chatbots at the community level, particularly in developing country settings, remains limited. Considering their potential to provide rapid, interactive, and evidence-based maternal health information, Meta-AI chatbots may represent a feasible and scalable approach for enhancing maternal health education and bridging service delivery gaps among underserved populations [11, 13]. Accordingly, this study aims to examine the effects of a Meta-AI chatbot intervention on improving pregnant women's capacity to access maternal and child health information.

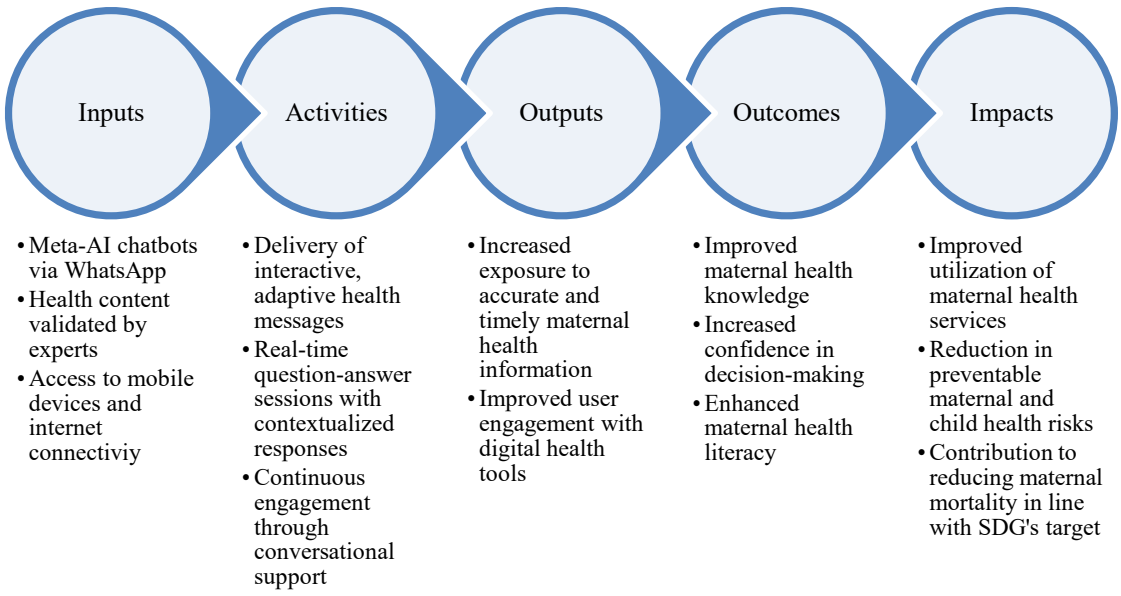

Figure 1. Framework Meta-AI Chatbots via WhatsApp Enhance Maternal Health Outcomes

Figure 1 clarifies the theoretical foundation of this intervention. A conceptual framework was developed to illustrate how the Meta-AI chatbot is expected to influence maternal health outcomes. The framework outlines the causal pathway through which the chatbot delivers adaptive, evidence-based, and context-specific health information, thereby improving knowledge, strengthening decision-making capacity, and ultimately enhancing the utilization of maternal health services. Additionally, the logic model highlights key mediators, such as health literacy, confidence, and engagement, alongside contextual factors, including socioeconomic status and digital access, which may affect the effectiveness of the intervention.

2. Method

This quantitative quasi-experimental study employed a one-group pretest-posttest design to assess the effect of Meta-Artificial Intelligence (Meta-AI) chatbot via WhatsApp on pregnant women's access to maternal and child health information. Thirty participants from a prenatal class in Singasari Village, Singaparna District, Tasikmalaya Regency, were recruited through purposive sampling. The inclusion criteria were smartphone ownership and willingness to participate, while exclusion criteria were cognitive, visual, or hearing impairments and incomplete participation. The Meta-AI chatbot combined rule-based and generative features, provided context-aware and adaptive responses, and supported multiple languages. Intervention materials were delivered through a booklet (Asking AI about Maternal Health: A Smart Way to Obtain Accurate Health Information) integrating text and illustrative graphics. Knowledge (prenatal care, nutrition, danger signs, infant care) and skills (ability to search, verify, and apply health information via the chatbot) were measured using ten-item validated questionnaires and scenario-based exercises scored with a standardized rubric. Variables were recoded into categorical levels (low, moderate, high) before analysis to facilitate interpretation. The pretest and posttest were administered on the same day, following a single training session, to minimize external influences and capture the immediate effects of the intervention.

Data were analyzed using both univariate and bivariate methods. Univariate analysis was employed to describe the distribution and characteristics of each research variable. Before bivariate analysis, data normality was assessed using the Shapiro-Wilk test. Results showed that the data were normally distributed ($p > 0.05$), allowing for parametric testing. Consequently, bivariate analysis was performed using paired simple t-tests to evaluate differences between pre- and post-intervention scores. Statistical significance was set at p <ss 0.05. In addition to the p-value, effect sizes were calculated using Cohen's *d* to determine the magnitude of observed differences. The study was conducted in May 2025 with ethical approval (No. 166/KEPK/SDHB/B/V/2025), and written informed consent was obtained from all participants.

3. Results and Discussion

3.1. Results

This section presents data on respondent characteristics, including maternal age, gestational age, parity, educational attainment, occupation, and experience with AI/chatbot services. The descriptive analysis highlights several key participant characteristics with important implications for maternal health, including maternal age, gestational age, parity, educational attainment, occupation, and prior experience with technology. A notable proportion of mothers fell into higher-risk age categories, with 16.7% younger than 20 years and 13.3% older than 35 years, suggesting increased vulnerability to pregnancy-related complications. The early gestational stage was relatively uncommon, with only 13.3% of participants in the first trimester. In comparison, grand multiparity was rare (3.3%), indicating that most participants had a low- to moderate-risk obstetric profile. Educational attainment

was generally moderate, with only one participant reporting elementary-level education, reflecting limited formal education within a small subset of the group. Notably, half of the respondents (50%) had never used AI- or chatbot-based health services, underscoring a substantial gap in digital health literacy and limited prior exposure to technology-assisted maternal health information. The data are presented in Table 1.

Table 1. Frequency Distribution of Respondent Characteristics

Characteristic		Frequency (F)	Percentage (%)
Maternal Age	<20 years old	5	16.7
	20-35 years old	21	70.0
	>35 years old	4	13.3
Gestational Age	1st Trimester	4	13.3
	2nd Trimester	12	40.0
	3rd Trimester	14	46.7
Parity	Primigravida	6	20.0
	Multigravida	23	76.7
	Grande Multigravida	1	3.3
Educational Attainment	Elementary School	1	3.3
	Junior High School	5	16.7
	Senior High School	16	53.3
	University	8	26.7
Occupation	Housewife	22	73.3
	Employee	2	6.7
	Laborer	2	6.7
	Entrepreneur	4	13.3
Experience with AI/Chatbot Services	Using it routinely	4	13.3
	Had used it occasionally	11	36.7
	Never	15	50

Based on Table 1, the descriptive analysis highlights several key participant characteristics with important implications for maternal health, including maternal age, gestational age, parity, educational attainment, occupation, and prior experience with technology. A notable proportion of mothers fell into higher-risk age categories, with 16.7% younger than 20 years and 13.3% older than 35 years, suggesting increased vulnerability to pregnancy-related complications. The early gestational stage was relatively uncommon, with only 13.3% of participants in the first trimester. In comparison, grand multiparity was rare (3.3%), indicating that most participants had a low- to moderate-risk obstetric profile. Educational attainment was generally moderate, with only one participant reporting elementary-level education, reflecting limited formal education within a small subset of the group. Notably, half of the respondents (50%) had never used AI- or chatbot-based health services, underscoring a substantial gap in digital health literacy and limited prior exposure to technology-assisted maternal health information.

Respondent characteristics were first collected, followed by an analysis of knowledge and skills scores before and after the intervention. Scores were categorized into three levels —low, medium, and high —to facilitate interpretation. Knowledge scores (0-10) were classified as low (0-3), moderate (4-7), and high (8-10), while skills scores (10-40) from a 10-item Likert scale were divided into equal-width categories: low (10-19), moderate (20-29), and high (30-40). The data are presented in Tables 2 and 3.

Table 2. Analyze the Level of Knowledge and Skills of Respondents Before Being Educated

Characteristic		Frequency (F)	Percentage (%)
Knowledge	Low	8	26.67
	Moderate	18	60
	High	4	13.33
Skills	Low	2	6.67
	Moderate	20	66.67
	High	8	26.67

Based on Table 2, the knowledge variable reflects the mother's level of knowledge before the provision of education. Most respondents were categorized as having a moderate level of knowledge (60.00%), followed by a low level (26.67%) and a high level (13.33%). Similarly, in terms of skills, most respondents were categorized as moderate (66.67%), while fewer were classified as high (26.67%), and the remainder were classified as low (6.67%).

Table 3. Analyze the Level of Knowledge and Skills of Respondents After Being Educated

Characteristic		Frequency (F)	Percentage (%)
Knowledge	Moderate	3	10
	High	27	90
Skills	Moderate	6	20
	High	24	80

Based on Table 3, the knowledge variable reflects the mother's level of knowledge after being educated. Most respondents were categorized as having a high level of knowledge (90%), followed by those with a moderate level (10%). Similarly, in terms of skills, most respondents were categorized as high (80%), while fewer were classified as moderate (20%).

Following the frequency distribution analysis of pregnant women's knowledge and skills before and after the educational intervention, a paired sample t-test was performed to analyze the bivariate relationship. Normality of the data was confirmed via the Shapiro-Wilk test, with p-values of 0.063 and 0.165 for knowledge and skills, respectively ($p > 0.05$), indicating that the data were normally distributed. Continuous data were therefore used for the paired sample t-test to assess the effect of Meta-AI-based education on improving access to maternal and child health information. The results of the pretest and posttest analyses for knowledge and skills are presented in Table 4, Figures 2 and 3.

Table 4. Paired sample t-test results for comparison of knowledge and skills levels of pretest and posttest respondents

Variable		N	Min	Max	Mean	Std. Dev	p-value	df	Cohen's d	95% CI	
										Lower	Upper
Knowledge	Pretest	30	2	9	5.00	2.00	<0.001	29	1.88	1.27	2.47
	Posttest	30	7	10	9.07	1.01					
Skills	Pretest	30	15	37	26.5	5.40	<0.001	29	2.31	1.61	2.99
	Posttest	30	29	40	36.7	3.02					

Based on Table 4, the paired-sample t-test demonstrated a statistically significant improvement in both knowledge and skills following the intervention. For knowledge, the mean score increased substantially from the pretest ($M = 5.00$, $SD = 2.00$) to the posttest ($M = 9.07$, $SD = 1.01$), with the difference reaching statistical significance ($p < 0.001$, $df = 29$). The effect size was substantial (Cohen's $d = 1.88$; 95% CI [1.27, 2.47]), indicating a robust positive effect of the intervention on participants' knowledge. Similarly, skills improved significantly from the pretest ($M = 26.5$, $SD = 5.40$) to the posttest ($M = 36.7$, $SD = 3.02$). The increase was statistically significant ($p < 0.001$, $df = 29$), with a huge effect size (Cohen's $d = 2.31$; 95% CI [1.61, 2.99]). These results suggest that the intervention produced substantial improvements in both knowledge and skills, with consistently strong and clinically meaningful effect sizes.

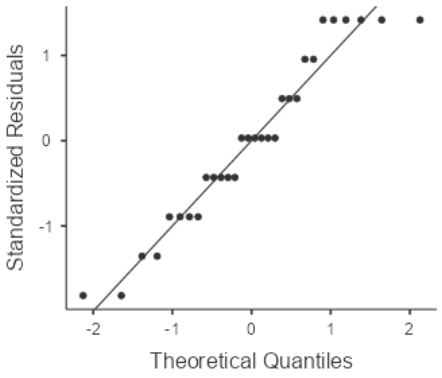

Figure 2. Plot a paired-sample t-test of knowledge

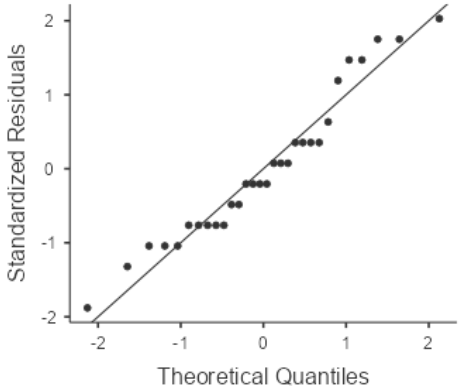

Figure 3. Plot a paired-sample t-test of skills

3.2. Discussion

This study demonstrated that the Meta-AI chatbot delivered via WhatsApp significantly improved pregnant women's maternal health knowledge and skills. The average knowledge score increased from 5.00 (SD = 2.00) to 9.07 (SD = 1.01), while the mean skills score rose from 26.5 (SD = 5.40) to 36.7 (SD = 3.02). Categorically, 90% of respondents achieved high knowledge levels after the intervention, compared to only 13.33% before, and 80% reached high skill levels post-intervention, compared to 26.67% previously. These results indicate that the intervention was not only effective in improving knowledge but had an even stronger effect on enhancing practical skills (Cohen's d = 2.31 for skills vs. 1.88 for knowledge), suggesting that experiential and interactive learning mechanisms embedded in the chatbot may have reinforced skill acquisition more robustly than knowledge recall. Similar findings have been reported in digital health education, where interactive, scenario-based, and problem-solving features promote deeper skill mastery compared to passive knowledge transfer [21].

These findings are consistent with prior studies that have demonstrated the effectiveness of digital interventions in enhancing maternal health outcomes. The "Rosie" chatbot in the United States improved maternal health literacy among minority women [22]. And a study in Iran also reported a 19% increase in health literacy scores after using a mobile application [23]. In Indonesia, research has shown that the use of chatbots in nutritional education for pregnant women positively impacted anemia knowledge improvement [24]. Significantly, our study extends this literature by employing a Meta-AI–driven chatbot that provides contextualized, adaptive responses beyond rule-based designs, while simultaneously assessing both knowledge and skills.

Moreover, this study makes further contributions by utilizing a Meta–AI–based chatbot that is capable of understanding context and providing more personalized and adaptive responses compared to decision–tree–based chatbots [19]. In addition, the study not only assessed knowledge but also examined skills, defined as the pregnant women's ability to access, verify, and independently apply MCH information. These results support previous findings that e-health literacy plays a crucial role in enhancing maternal readiness for childbirth [25].

The effectiveness of the Meta-AI chatbot intervention can be attributed to several key mechanisms. First, microlearning, which delivers content in small, easily revisitable segments, strengthens user comprehension and engagement, as demonstrated by a recent study that found that chatbot-based microlearning improves understanding among parents and expectant mothers [26]. Second, Meta-AI technology enables personalized and adaptive interactions, where the chatbot adjusts language and content to suit the user's profile. This was evident in the development of the

"Dr. Joy" chatbot for obstetric and mental health care, where users responded positively to dialogues that felt contextual and empathetic [17]. Third, 24/7 accessibility enables pregnant women to access information at any time, without the constraints of face-to-face schedules. The GisSa Mother-Baby Chatbot study reported that over 90% of users found the chatbot practical, with clear information quality and easy accessibility at any time [27].

Furthermore, the self-directed learning process empowers users to explore materials, revisit explanations, and ask specific questions. This advantage was highlighted in a mixed-methods study on micro-interventions via public health chatbots, emphasizing user engagement and personalization as key to effectiveness [28]. In Indonesia, access to MCH information often remains fragmented and uneven, especially in regions with suboptimal digital infrastructure [29, 30]. The fact that 50% of respondents in this study had never used AI services before reflects a digital literacy gap. However, the significant score improvements after the intervention indicate that AI-based chatbots can be rapidly adopted, even by novice users.

This study, however, has several limitations. First, the intervention was conducted in a single, short session, which limited the assessment of long-term retention. Second, the absence of a control group restricts causal inferences, as external factors might partly influence improvements. Third, the reliance on self-reported questionnaire data introduces the risk of response bias, particularly in skill assessment. Nevertheless, the study has notable strengths: it is among the first in Indonesia, especially in Singasari Village, to evaluate a Meta-AI–powered chatbot for maternal health education, it combines both knowledge and skill outcomes rather than focusing on one domain, and it demonstrates feasibility even among participants with limited prior exposure to AI technology.

Future research should adopt longitudinal designs to measure knowledge and skill retention over time, incorporate control or comparison groups to strengthen causal claims, and explore the integration of chatbot interventions into national maternal health applications to support scalability. Additionally, developing personalized chatbot features tailored to user literacy levels, pregnancy stage, and cultural context could further enhance engagement and effectiveness.

4. Conclusion

This research demonstrates that education facilitated by Meta-AI chatbots significantly enhances pregnant women's knowledge and competencies in accessing information related to maternal and child health (MCH). The noted enhancements indicate that AI-driven therapies are both feasible and scalable for implementation in communities with restricted access to conventional health services. These findings highlight the capacity of conversational AI to address digital literacy disparities and promote maternal health equity. Subsequent studies must investigate long-term effects, incorporation into national health systems, and user experiences among various demographics to fully harness the transformative potential of AI in promoting maternal health.

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Conflict of Interest

The authors state that no conflict of interest exists regarding this research.

REFERENCES

1. Perez K, Wisniewski D, Ari A, Lee K, Lieneck C, & Ramamonjiarivelo Z. Investigation into Application of AI and Telemedicine in Rural Communities: A Systematic Literature Review. Healthcare. 2025;13:3:324. https://doi.org/10.3390/healthcare13030324
2. Sylla B, Ismaila O, Diallo G. 25 Years of Digital Health Toward Universal Health Coverage in Low- and Middle-Income Countries: Rapid Systematic Review. J Med Internet Res 2025;27: 59042. https://doi.org/10.2196/59042
3. Syairaji M, Nurdiati DS, Wiratama BS, Prust ZD, Bloemenkamp KWM, Verschueren KJC. Trends and causes of maternal mortality in Indonesia: a systematic review. BMC Pregnancy Childbirth. 2024;24:1:515. https://doi.org/10.1186/s12884-024-06687-6
4. Suparji S, Nugroho HSW, Sunarto S, Prayogi AS. High maternal mortality rate in Indonesia: a challenge to be addressed immediately. PAMJ One Health. 2024;14:13:1-6. https://doi.org/10.11604/pamj-oh.2024.14.13.44464
5. UNICEF. Maternal mortality [Internet]. UNICEF Data. 2025. Available from: https://data.unicef.org/topic/maternal-health/maternal-mortality.
6. WHO. World health statistics 2024: monitoring health for the SDGs, sustainable development goals. World Health Organization. 2024. Available from: https://www.who.int/publications/i/item/9789240094703
7. Jariyah A, Sudiamin FH, Syahridayanti S, Arliatin A, Astuti A. Factors affecting health literacy among pregnant women in the Moncongloe Community Health Center area. Afiasi Jurnal Kesehatan Masyarakat. 2024;9:165–178. https://doi.org/10.31943/afiasi.v9i2.363
8. Handayani S, Milie P. Pengaruh Pendidikan Kesehatan melalui Whatsapp Group terhadap Pengetahuan dan Sikap Ibu Hamil dalam Deteksi DIni Preeklampsia pada Masa Pandemi COVID-19. Jurnal Kebidanan. 2020;12:217–230. https://doi.org/10.35872/jurkeb.v12i02.394
9. Adedokun ST, Yaya S. Factors influencing mothers' health care seeking behaviour for their children: evidence from 31 countries in sub-Saharan Africa. BMC Health Serv Res. 2020;20:842. https://doi.org/10.1186/s12913-020-05683-8
10. Pavalagantharajah S, Negrin AR, Bouzanis K. et al. Facility-Based Maternal Quality of Care Frameworks: A Systematic Review and Best Fit Framework Analysis. Matern Child Health J. 2023;27:1742–1753. https://doi.org/10.1007/s10995-023-03702-8.
11. Khan M, Vatsa M, Singh K, Khurshid M, Singh R, Duggal M. On AI Approaches for Promoting Maternal and Neonatal Health in Low Resource Settings: A Review. Front Public Health. 2022;10: 880034. https://doi.org/10.3389/fpubh.2022.880034
12. Collins TE, Akselrod S, Altymysheva A, Nga PTQ, Banatvala N, Berlina D. The promise of digital health technologies for integrated care for maternal and child health and non-communicable diseases. BMJ. 2023;381:071074. https://doi.org/10.1136/bmj-2022-071074
13. Ahmad SG, Iqbal T, Javaid A, Munir EU, Kirn N, Jan SU, Ramzan N. Sensing and Artificial Intelligent Maternal-Infant Health Care Systems: A Review. Sensors. 2022;22:12:4362. https://doi.org/10.3390/s22124362
14. Ramadhan AR. Strategi penggunaan chatbot artificial intelligence dalam pembelajaran Bahasa Arab pada perguruan tinggi di Indonesia. Journal Oase. 2023;2:77–86. Retrieved from https://ejurnal.kptk.or.id/oase/article/view/32
15. Darcy A, Robinson A, Wicks P. Conversational Agents in Health Care. JAMA. 2020;324:23:2444. https://doi.org/10.1001/jama.2020.21509
16. Kang B, Hong M. Development and Evaluation of a Mental Health Chatbot Using ChatGPT 4.0: Mixed Methods User Experience Study With Korean Users. JMIR Med Inform. 2020;13:63538. https://doi.org/10.2196/63538
17. Chung K, Cho HY, Park JY. A Chatbot for Perinatal Women's and Partners' Obstetric and Mental Health Care: Development and Usability Evaluation Study. JMIR Med Inform. 2021; 9:3:18607. https://doi.org/10.2196/18607
18. Kim HK.The Effects of Artificial Intelligence Chatbots on Women's Health: A Systematic Review and Meta-Analysis. Healthcare (Basel, Switzerland). 2024;12:5:534. https://doi.org/10.3390/healthcare12050534

19. McAlister K, Baez L, Huberty J, Kerppola M. Chatbot to Support the Mental Health Needs of Pregnant and Postpartum Women (Moment for Parents): Design and Pilot Study. JMIR Form Res. 2025;9:72469. https://doi.org/10.2196/72469
20. Milne-Ives M, deCock C, Lim E, Shehadeh MH, de Pennington N, Mole G, Normando E, Meinert E.The Effectiveness of Artificial Intelligence Conversational Agents in Health Care: Systematic Review. J Med Internet Res. 2020;22:10:20346. https://doi.org/10.2196/20346
21. Han JW, Park J, & Lee H. Development and effects of a chatbot education program for self-directed learning in nursing students. BMC Med Educ. 2025;25:825. https://doi.org/10.1186/s12909-025-07316-2
22. Nguyen QC, Aparicio EM, Jasczynski M, Doig AC, Yue X, Mane H, Srikanth N, Gutierrez FXM, Delcid N, He X. Rosie, a Health Education Question-and-Answer Chatbot for New Mothers: Randomized Pilot Study. JMIR Form Res. 2024;8:51361. https://doi.org/10.2196/51361
23. Karamolahi PF, Khalesi ZB, Niknami M. Efficacy of mobile app-based training on health literacy among pregnant women: A randomized controlled trial study. Eur J Obstet Gynecol Reprod Biol X. 2021;12:100133. https://doi.org/10.1016/j.eurox.2021.100133
24. Irawan AMA, Cholidhazia P, Koiriyah T, Orchidhea KR, Denaneer K, Harna H. Efektivitas Chatbot sebagai Media Edukasi untuk Meningkatkan Pengetahuan dan Sikap Ibu Hamil terkait Gizi dan Anemia Gizi. Ghidza: Jurnal Gizi Dan Kesehatan. 2023;7:337–346. https://doi.org/10.22487/ghidza.v7i2.1054
25. Zhou N, Wu D, Liu M, Hu S, Zhang F, Zan Y, Sun F. The mediating role of self-efficacy in the relationship between eHealth literacy and childbirth readiness among pregnant women: a cross-sectional study. Front Public Health. 2025;13:1561855. https://doi.org/10.3389/fpubh.2025.1561855
26. Chua JYX, Choolani M, Chee CYI, Chan YHC, Lalor JG, Chong YS, Shorey S. Insights of Parents and Parents-To-Be in Using Chatbots to Improve Their Preconception, Pregnancy, and Postpartum Health: A Mixed Studies Review. J Midwifery Womens Health. 2023;68:480–489. https://doi.org/10.1111/jmwh.13472
27. Barreto ICHC, Barros NBS, Theophilo RL, Viana VF, Silveira FRV, Souza O, Sousa FJG, Oliveira AMB, & Andrade LOMICHC, Barros NBS, Theophilo RL, Viana VF, Silveira FRV, Souza O, Sou LOM. Development and evaluation of the GISSA Mother-Baby ChatBot application in promoting child health. Cien Saude Colet. 2021;26:5:1679–1690. https://doi.org/10.1590/1413-81232021265.04072021
28. Ali SH, Rahman F, Kuwar A, et al. Rapid, Tailored Dietary and Health Education Through A Social Media Chatbot Microintervention: Development and Usability Study With Practical Recommendations. JMIR Form Res. 2024:8:52032. https://doi.org/10.2196/52032
29. Putri AP, Hanifah L, AM AI, Lu YY. Maternal health literacy among pregnant women in Indonesia: A qualitative study. IJNHS: International Journal of Nursing and Health Service. 2023;6:6:354-364. https://doi.org/10.35654/ijnhs.v6i6.763
30. Ningrum EW, Lusmilasari L, Huriyati E, Hasanbasri M. Experiences of Low-Income Indonesian Pregnant Women Regarding the Challenges of Receiving Health Services: A Qualitative Content Analysis. Int J Community Based Nurs Midwifery. 2024;12:4:278–288. https://doi.org/10.30476/ijcbnm.2024.101795.2447