

The Effectiveness of Digital Technology-Based Health Education Approaches in Increasing Antenatal Care Compliance Among Pregnant Women in Indonesia

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Abstract: Indonesia continues to face a high maternal mortality rate (MMR), partly due to low compliance with antenatal care (ANC) visits despite the national recommendation of at least six check-ups during pregnancy. This study aimed to evaluate the effectiveness of digital technology-based health education in improving ANC compliance among pregnant women in several Puskesmas working areas. A longitudinal intervention study with a quantitative pretest–posttest design was conducted involving 30 respondents selected using G-Power and distributed across three Puskesmas. The intervention consisted of structured health education delivered through digital media. The findings showed a significant increase in ANC compliance after the intervention in all locations, with statistical analysis indicating $p < 0.05$, confirming the effectiveness of digital-based education in improving routine examination adherence. The results demonstrate measurable behavioral change following the intervention, reflected in higher compliance levels post-education. This study contributes to science-based health education by demonstrating that digital learning media can function as an applied, contextual approach to strengthening maternal health literacy and promoting evidence-based behavioral change.

Keywords: Antenatal care; Compliance; Digital education

Introduction

Indonesia's Maternal Mortality Rate (MMR) remains high at 305 per 100,000 live births, indicating that national progress has not yet aligned with the Sustainable Development Goals (SDGs) target of 183 per 100,000 live births by 2024 (Ministry of Health Republic of Indonesia, 2023). Strengthening maternal health services is therefore a priority, and antenatal care (ANC) compliance is a critical leverage point because routine ANC visits enable early detection of pregnancy risks, timely referrals, and preventive counseling. However, compliance remains suboptimal even though the national standard recommends a minimum of six ANC visits during pregnancy (Ministry of Health Republic of Indonesia, 2023).

One major determinant of ANC utilization is health literacy – pregnant women's ability to access, understand, and use science-based health information in making decisions throughout pregnancy. Evidence indicates that ANC adherence is influenced by knowledge level, family support, accessibility of services, and exposure to credible information sources (Famutimi et al., 2025). In practice, conventional face-to-face counseling in primary care may be constrained by limited time, inconsistent message delivery, and restricted reach to all target groups, especially when pregnant women have competing domestic or work responsibilities (Ahmad et al., 2025; Famutimi et al., 2025; Hidayati et al., 2026). These constraints underscore the need for scalable educational strategies that maintain

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content consistency and reinforce learning beyond clinic visits.

Digital technology offers a practical pathway to deliver structured, repeatable, and accessible health education. Mobile health (mHealth) platforms can support learning without strict time-place limitations and can facilitate monitoring and follow-up communication between healthcare providers and pregnant women (Istepanian, 2022; Noorbhai et al., 2023; Samari et al., 2024). In Indonesia, the Ministry of Health has introduced digital health initiatives for maternal services, including the Sehat IndonesiaKu (ASIK) application, as part of the broader digital health transformation (Ministry of Health Republic of Indonesia, 2024). Digital educational media (e.g., mobile modules, short instructional videos, and reminders) may accelerate knowledge transfer, enable independent repetition of key concepts, and strengthen intention-to-action pathways that support routine ANC attendance (Abbasalizadeh et al., 2024; Famutimi et al., 2025; Istepanian, 2022; Messner et al., 2023).

Despite this potential, empirical evidence on whether digital technology-based health education produces measurable improvements in ANC compliance—particularly within Puskesmas settings—remains limited. Existing studies frequently emphasize technical development of applications or cross-sectional determinants of ANC adherence, rather than evaluating intervention effects over time (Famutimi et al., 2025). Moreover, longitudinal evidence is needed to demonstrate that digital education is not only informative but also capable of driving sustained behavioral change, which is essential for public health impact. Implementation challenges at the primary care level (e.g., uneven digital readiness among health workers, infrastructure variability, and community digital literacy) further justify context-specific evaluations in real service settings.

This study addresses that gap by testing a digital technology-based health education intervention using a longitudinal quantitative pretest-posttest approach across three Puskesmas working areas—Klender II, Kutamukti, and Gunung Kaler—which represent urban and semi-urban contexts with diverse socioeconomic characteristics and basic infrastructure supportive of digital delivery. The novelty of this study lies in its focus on behavioral outcomes (ANC compliance) assessed longitudinally in frontline primary care, providing applied evidence for scalable maternal health education. In addition, this research contributes to science-based health education by positioning ANC learning content as contextual applied science: digital media are used to strengthen health science literacy, enabling pregnant women to interpret evidence-based messages and

translate them into preventive health actions through routine ANC attendance.

Method

Research Design

This study employed a longitudinal intervention design with a quantitative one-group pretest-posttest approach. The intervention consisted of digital technology-based health education delivered to pregnant women, and outcomes were measured before (pretest) and after (posttest) the intervention to evaluate changes in ANC compliance (primary outcome) and knowledge and attitudes (secondary outcomes).

Setting and Participants

The study was conducted in the working areas of three Puskesmas (Klender II, Kutamukti, and Gunung Kaler) in 2025. The target population was pregnant women registered in the selected Puskesmas areas.

Inclusion criteria: pregnant women who (1) were registered at the Puskesmas, (2) agreed to participate, and (3) had access to a mobile phone/WhatsApp (or other platform used in the intervention). Exclusion criteria: participants who did not complete the intervention period or did not complete either the pretest or posttest measurement.

Sample Size and Sampling Technique

The minimum sample size was calculated using G*Power version 3.1.9 with parameters: effect size (d) = 0.5, α = 0.05, and power ($1-\beta$) = 0.95. The calculation indicated a minimum sample requirement of 30 respondents, who were then recruited from the intervention areas.

Intervention Procedure (Digital Health Education)

The intervention was a structured digital health education program delivered through digital media. It included: (1) Educational content (maternal health and ANC importance, pregnancy danger signs, ANC schedule, benefits of routine check-ups) delivered in digital formats (e.g., short videos/posters/modules). (2) Reinforcement messages and reminders (digital reminders regarding ANC schedules and key health messages). (3) Follow-up interaction (limited Q&A/clarification via the digital platform to ensure comprehension, if applied).

Pretest assessment was conducted prior to receiving digital education. Posttest assessment was conducted after the intervention period using the same measurement instruments.

Variables and Operational Definitions

Primary outcome: ANC compliance. ANC compliance was defined as the participant's adherence to the national ANC standard of at least six visits during pregnancy. Compliance was measured using documentation/records of ANC visits (e.g., KIA book or Puskesmas register). Participants were categorized as:

- Compliant: achieved ≥ 6 ANC visits during pregnancy, or met the required visit schedule according to gestational age during the intervention period.
- Non-compliant: did not meet the minimum required visits/schedule.

Secondary outcomes:

- Knowledge score: measured using a structured questionnaire on ANC and maternal health (pretest-posttest).
- Attitude score: measured using a Likert-scale instrument assessing attitudes toward routine ANC visits (pretest-posttest).

Data Collection Instruments

Data were collected using: (a) A structured questionnaire for knowledge and attitudes (administered at pretest and posttest). (b) ANC visit data

extracted from maternal records (KIA book/Puskesmas register) to determine compliance.

Data Analysis

Data analysis was conducted in two stages: (a) Descriptive statistics: frequency, percentage, mean/median (as appropriate) for participant characteristics and outcome variables. (b) Inferential statistics (pretest-posttest comparison): If the outcome data were normally distributed: Paired Sample t-test was used. If the data were not normally distributed: Wilcoxon Signed-Rank test was applied.

Result and Discussion

This section presents the frequency distribution of ANC adherence levels among pregnant women before and after a digital technology-based health education intervention. The data were derived from adherence measurements—using ANC adherence scores—conducted on respondents across three Community Health Center (Puskesmas) service areas ($n = 30$ for each). Score categories were used to classify adherence as follows: Obedient (score of 8), Quite Obedient (scores of 6–8), and Not Obey (score < 6).

Table 1. Distribution of ANC Compliance Levels Before Intervention (Pretest)

Research Area	Obedient (score 8) n (%)	Quite Obedient (score 6–8) n (%)	Not Obey (score < 6) n (%)	Total n (%)
PKM Assistant Klender II Jakarta	8 (26.7)	12 (40.0)	10 (33.3)	30 (100.0)
PKM Kutamukti	8 (26.7)	8 (26.7)	14 (46.7)	30 (100.0)
PKM Gunung Kaler	7 (24.5)	5 (16.7)	18 (58.9)	30 (100.0)

At the pre-intervention stage, the proportion of respondents in the "Not Obey" category remained high, particularly at the Gunung Kaler Community Health Center (18 respondents; 58.9%). Meanwhile, the "Obedient" category showed relatively similar figures

across the three locations (24.5%–26.7%). These findings indicate that, prior to digital education, ANC adherence was uneven and characterized by predominantly low adherence levels in certain locations.

Table 2. Distribution of ANC Compliance Levels After Intervention (Posttest)

Research Area	Obedient (score 8) n (%)	Quite Obedient (score 6–8) n (%)	Not Obey (score < 6) n (%)	Total n (%)
PKM Assistant Klender II Jakarta	22 (73.3)	8 (26.7)	0 (0.0)	30 (100.0)
PKM Kutamukti	19 (63.3)	11 (36.7)	0 (0.0)	30 (100.0)
PKM Gunung Kaler	21 (70.0)	9 (30.0)	0 (0.0)	30 (100.0)

Following the intervention, there was a shift in the distribution of compliance toward higher categories. All areas showed the disappearance of the "Not Obey" category (0%), and the proportion of "Obedient" cases rose sharply: reaching 73.3% in Klender II, 63.3% in Kutamukti, and 70.0% in Gunung Kaler. This pattern indicates a consistent improvement in ANC compliance following digital education.

The present study demonstrates that digital technology-based health education produced a meaningful improvement in ANC compliance across three Puskesmas, reflected by the disappearance of the "non-compliant" category (0% post-intervention in all sites) and a marked increase in the "compliant/obedient" category (e.g., Klender II 26.7%→73.3%; Kutamukti 26.7%→63.3%; Gunung Kaler

24.5%→70.0%). This pattern is important in the Indonesian context because national policy emphasizes continuity of ANC and highlights substantial drop-off

from early ANC to later visits, indicating persistent gaps in completing recommended care (Ministry of Health Republic of Indonesia, 2023).

Table 3. Pretest–Posttest Comparison of ANC Compliance Scores by Region

Region	Measurement	N	Mean Rank	SD	p-value
PKM Assistant Klender II	Pretest	30	4.421	2.06667	0.001
	Posttest	30	15.425	1.26667	
PKM Kutamukti	Pretest	30	4.228	2.20890	0.003
	Posttest	30	14.272	1.36667	
PKM Gunung Kaler	Pretest	30	4.366	2.30000	0.001
	Posttest	30	18.425	1.10870	

The consistent significance of pretest–posttest differences in each site (Wilcoxon Signed-Rank Test, $p < 0.05$) suggests that the intervention affected not only awareness but also behavior. Mechanistically, this is plausible because digital education supports “targeted client communication” (e.g., reminders and stage-based messaging) and improves access to standardized content outside clinic hours, which WHO identifies as a recommended digital function when implemented with attention to acceptability, feasibility, and equity. In other words, the intervention likely strengthened “cues to action” and reduced informational barriers that commonly disrupt routine maternal service utilization (WHO, 2019).

These findings align with accumulating evidence that SMS and mobile-based interventions can improve ANC attendance, maternal knowledge, and health behaviors in low- and middle-income settings. A recent systematic review of SMS-based ANC interventions reported that reminders are the most common component and that combining reminders with educational messages tends to yield stronger improvements in ANC outcomes, although effectiveness varies by context and implementation quality (Kante et al., 2025). Evidence from a systematic review and meta-analysis also supports the positive impact of SMS reminders on maternal service uptake in LMICs, reinforcing the plausibility of the observed compliance gains in this study (Hailemariam et al., 2025).

Indonesia-specific evidence further strengthens the interpretation of the present results. A quasi-experimental study in Bekasi reported that a mobile-based reminder system significantly improved ANC utilization domains compared with conventional services, highlighting that reminder-enabled digital interventions can shift utilization outcomes in Indonesian settings (Tridiyawati et al., 2025). In addition, research on mHealth development for midwifery continuity of care in Indonesia emphasizes that digital tools can support service needs but must be aligned with midwives’ competencies and workflow realities—an important implementation consideration

for scaling interventions in Puskesmas (Susanti et al., 2022).

The site-level pattern is also noteworthy: Gunung Kaler had the highest baseline proportion of non-compliance yet improved to 0% non-compliance post-intervention. This suggests digital education may help narrow inequities driven by differences in information exposure and follow-up capability, particularly where conventional counseling is less consistently accessed. Broader reviews conclude that mHealth can improve access and utilization of maternal and child health services but stress that effectiveness is mediated by contextual barriers (digital access, literacy, service readiness), which should be explicitly addressed during scale-up (Venkataramanan et al., 2022; WHO, 2019).

From a health literacy and behavior-change standpoint, the observed improvement is consistent with established frameworks that conceptualize health literacy as progressing from functional understanding to interactive and critical application of information in real-life decisions. Digital education can reinforce repeated exposure, simplify risk messaging, and facilitate comprehension, which supports movement from “knowing” to “doing” (Çallışkan et al., 2021; Nutbeam, 2008). In maternal care, improved health literacy is expected to strengthen perceived benefits and self-efficacy for routine ANC attendance, particularly when educational content is delivered in short, repeatable, and actionable segments (Çallışkan et al., 2021; Nutbeam, 2008).

The contribution to JPPIPA’s scope can be stated more explicitly: ANC education is fundamentally applied science learning (risk identification, preventive monitoring, evidence-based decision-making), and digital delivery operationalizes contextual science-based education for community health. This aligns with work in JPPIPA that discusses integrating health literacy into science learning and positioning health issues as contextual anchors to strengthen scientific literacy outcomes (Lasminawati et al., 2022). Moreover, global digital health guidance emphasizes the importance of evidence-informed implementation and evaluation of

digital interventions rather than technology adoption alone—consistent with the applied-science orientation expected in JPPIPA manuscripts (Labrique et al., 2020).

In terms of implementation, the observed gains support integrating digital education with existing primary-care digital ecosystems and workflows. Indonesia's ASIK platform is positioned to support recording and monitoring at the primary-care level and includes channels such as mobile and a WhatsApp chatbot, which can reduce operational friction for frontline staff while maintaining consistent messaging and follow-up (Ministry of Health Republic of Indonesia, 2024). Consistent with WHO guidance, scale-up should include training, usability checks, content standardization, and monitoring indicators that capture both engagement (message exposure, completion) and outcomes (visit completion to ANC6/K6) (Ministry of Health Republic of Indonesia, 2024; WHO, 2019).

Several limitations should be addressed to strengthen causal inference and manuscript rigor. A one-group pretest-posttest design is vulnerable to history/maturation effects; future work should prioritize control/comparison groups and report effect sizes alongside p-values to improve interpretability and comparability across studies. Reviews of mHealth for maternal health consistently recommend stronger designs, larger samples, and attention to context-specific barriers (digital divide, service readiness) to ensure that measured improvements are robust and scalable (Labrique et al., 2020; Venkataramanan et al., 2022). In addition, the operational definition of "ANC compliance" should be stated consistently as meeting the national minimum ANC service standard (minimum 6 visits), and the compliance scoring categories should avoid overlap to improve measurement validity (Ministry of Health Republic of Indonesia, 2023; WHO, 2019).

Conclusion

This study concludes that digital technology-based health education significantly improves antenatal care (ANC) compliance among pregnant women in three Puskesmas working areas in Indonesia in 2025, evidenced by the shift of participants into higher compliance categories after the intervention and statistically significant pretest-posttest differences in all sites (Wilcoxon Signed-Rank Test, $p < 0.05$). The findings indicate that digital education can function as an applied, contextual, science-based learning approach that strengthens maternal health literacy and translates evidence-based messages into preventive health behaviors, supporting efforts to improve routine ANC utilization in primary care.

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Author Contributions

L.I., N.K., F.Y., R., D.A.R., and N. contributed collectively to all stages of the research process. Conceptualization was carried out jointly by L.I., N.K., F.Y., R., D.A.R., and N. Data collection was conducted collaboratively by L.I., N.K., F.Y., R., D.A.R., and N. Data processing and analysis were performed by L.I., N.K., F.Y., R., D.A.R., and N. Manuscript preparation and writing were undertaken by L.I., N.K., F.Y., R., D.A.R., and N., including drafting, revising, and finalizing the article. All authors have read and approved the final manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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