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Immediate Changes in ANC K6 Knowledge and Attitudes Following Blended e-CINTA BUNDA Digital Education

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ABSTRACT

Introduction *Incomplete attendance of the sixth antenatal care visit (ANC K6) remains a challenge in maternal health care. Limited knowledge and negative attitudes among pregnant women can contribute to incomplete use of ANC services. Digital health education can provide accessible strategies to strengthen maternal health literacy. The study aimed to assess immediate changes in knowledge and attitudes regarding ANC K6 following a blended education intervention using e-CINTA BUNDA among pregnant women.* ***Methods*** *A pre-experimental one-group pretest-posttest design was conducted among 72 pregnant women at Puskesmas Banjarsengon, using attendance-based convenience sampling. The 45-minutes blended intervention combined face - to face education and the e-CINTA BUNDA, a Google Sites-based digital platform containing information about ANC K6, pregnancy nutrition, warning signs, pregnancy complications, and childbirth preparation. Knowledge and attitudes were measured using questionnaires before and immediately after the intervention within the same session. Data were analyzed using the Wilcoxon signed-rank test.* ***Results*** *The mean knowledge score increased from 5.86 to 10.03 ($Z = -7.117$; $p < 0.001$; $r = 0.84$), and the mean attitude score increased from 38.32 to 43.47 ($Z = -6.918$; $p < 0.001$; $r = 0.82$) both with large effect sizes.* ***Discussion*** *Blended education using e-CINTA BUNDA was associated with immediate improvements in ANC K6 knowledge and attitudes among pregnant women. This platform can support maternal health education in primary care settings. However, the absence of a control group limits causal interpretation, and further controlled studies are needed to evaluate its sustained impact.*

Keywords: *digital education, antenatal care, e-CINTA BUNDA, pregnant women, knowledge, attitude*

INTRODUCTION

Indonesia still faces a serious public health problem, namely the high maternal mortality rate. The maternal mortality rate is one of the indicators used to assess public health. Based on data from the Indonesian Health Profile (2025), the maternal mortality rate decreased from 390 deaths per 100,000 live births in 1991 to 189 in 2020. Despite the decline, further efforts are still needed to accelerate the reduction in maternal mortality and achieve the Sustainable Development Goal (SDG) target of 70 deaths per 100,000 live births by 2030 [1]. One of the prevention of increased maternal mortality is to conduct regular pregnancy checkups. Through this pregnancy check-up, complications during pregnancy can be detected and treated from the beginning of pregnancy [2]. The government through the Regulation of the Minister of Health of the Republic of Indonesia Number 21 of 2021 stipulates the number of ANCs 6 times, consisting of 1 examination in the first trimester, 2 times in the second trimester, and 3 times in the third trimester [3]. Based on the 2025 Indonesian Health Profile, the coverage of six pregnancy examinations (K6) nationally reached 78.21%, a figure below the target of 80% set in the 2025 National Strategic Plan [1]. In East Java Province, based on data from the East Java Health Profile 2025, K6 coverage in East Java reached 74.4% and in Jember Regency only reached 64.6% [4]. This data shows that the completeness of the six-time pregnancy check-up is still challenge so further research is needed on the factors related to the incompleteness of ANC visits.

Several factors may be involved with the low coverage of K6 such as age, parity, level of knowledge, geography, transportation, socio-culture and infrastructure [5]. These factors interact with each other which shows that compliance to make ANC visits up to 6 times is not only influenced by health service aspects, indicating that the completion of six ANC visits can be associated by individual characteristics and the surrounding environment [6].

Knowledge is a key determinant of a mother's adherence to antenatal care (ANC) visits. A high level of knowledge regarding the benefits of check-ups, visit schedules, pregnancy-related dangers, and complication risks can serve as a foundation for shaping the attitudes and behaviors associated with seeking healthcare services [7]. Previous research conducted by Winda et al. [8] showed that there was a significant relationship (p=0.001) between the knowledge of pregnant women and the number of ANC visits. However, other studies

conducted at the Pauh Health Center in Padang City had different results where there was no significant relationship in this study [9]. These conflicting results suggest that the relationship between maternal knowledge and the use of prenatal care services may vary depending on the research context, and they highlight the need to consider not only factors determining healthcare access but also other personal factors when studying prenatal care participation.

Several studies have reported that education in the form of face-to-face counseling can increase pregnant women's knowledge and attitudes towards pregnancy examinations [10]. But, their reach may be restricted by the limited number of health workers, the time of pregnant women to participate in activities, and the difficulty of accessing transportation [11]. One of the other strategies to increase the coverage of K6 visits for pregnant women is to utilize technological developments. A study conducted by Treasa et al., (2026) reported that mobile health-based interventions (mHealth) can increase the knowledge and compliance of pregnant women [12]. Another research conducted by Srimulyawati et al., (2026) using *Whatsapp group media* can effectively increase the knowledge of pregnant women, especially about pregnancy danger signs [13]. The findings of this study indicate that maternal health education can be supported by digital-based educational interventions. However, their impact on health literacy, antenatal care (ANC) attendance rates, and self-care practices must be interpreted by considering the specific outcomes measured in each study.

Although previous studies have reported that digital educational media can serve as an alternative solution for enhancing the knowledge of pregnant women, further evaluation is needed to assess changes in knowledge and attitudes following website-based education specifically addressing the importance of completing the six recommended prenatal care visits (K6). Furthermore, evidence regarding the impact of combined educational interventions delivered within primary healthcare settings remains limited. This gap highlights the needs to evaluate changes in pregnant women's knowledge and attitudes regarding K6 immediately after receiving a combined educational intervention that incorporates the use of a website at primary healthcare facilities.

The LANCAR K6 program through e-CINTA BUNDA digital media based on Google Sites was designed to address gaps in pregnant women's understanding of the importance of completing ANC K6 visits. This platform provides materials about ANC K6, benefits and visit

schedules, danger signs and risk factors for pregnancy, nutrition, Fe tablets, pregnancy complications, childbirth preparation, and educational materials in the form of e-books, videos, and digital leaflets. This study aims to evaluate immediate changes in pregnant women's knowledge and attitudes regarding the K6 prenatal care model following the implementation of a blended educational intervention that combines the e-CINTA BUNDA platform with in-person information sessions and discussions within a primary care system. It also describes a use case for the platform as a supplementary educational resource within routine maternal and child health care.

METHODS

Study design. This quantitative study used a one-group pretest-posttest design. A comparison group was not formed because the program was implemented during a limited stay, and all participating pregnant women were eligible to receive the same education. In the absence of a comparison group, changes in scores may also have been influenced by retesting effects, assistance from the team during the data entry process, or other factors. Therefore, the results of this study indicate changes that occurred immediately after the education was provided, rather than evidence of causal effectiveness.

Setting. The study was conducted in the service area of UPTD Puskesmas Banjarsengon, Patrang Subdistrict, Jember Regency, in four sessions: Bintoro (20 July 2026), Jumerto (27 July 2026), and the health center's maternal and child health (MCH) room and Slawu (28 July 2026).

Participants. The 576 pregnant women targeted in the health center’s service area in 2025 was a service target and not the sampling frame of this study; the number of eligible women in July 2026 was not available. Recruitment was attendance-based (non-probability convenience sampling) rather than consecutive: enrolment was not based on a complete list of eligible women, and not every eligible woman in the service area had the opportunity to be enrolled. Health cadres invited 34 pregnant women from the cohort registers of Bintoro and Jumerto, but not all attended; recruitment therefore continued through the pregnancy class in the health center’s MCH room (attended by women coming for antenatal visits) and in Slawu.

At each session, all women present who met the eligibility criteria and gave written informed consent were enrolled, so the final sample (n = 72) exceeded the calculated minimum (see below). Inclusion criteria were pregnancy in any trimester, residence in the study area, and access to a smartphone with active WhatsApp; exclusion criteria were emergency conditions or communication/cognitive impairments preventing questionnaire completion.

The minimum sample size, calculated with G*Power 3.1 (matched-pairs t-test, two-sided, dz = 0.50 as a moderate effect per Cohen in the absence of comparable baseline data, $\alpha = 0.05$, power = 0.80), was 34, or 40 after allowing for 15% dropout. Because the asymptotic relative efficiency of the Wilcoxon signed-rank test is at least 0.864 relative to the paired t-test, the final sample of 72 met the requirements of both tests. All participants completed the pretest, intervention, and posttest, with no withdrawals.

Variables. The independent variable was the LANCAR K6 intervention combined with e-CINTA BUNDA. The dependent variables were knowledge and attitudes regarding ANC K6, which were measured before and after the intervention. Maternal characteristics and ANC history were recorded as descriptive variables.

Intervention. The LANCAR K6 program (Lanjut ANC, Antisipasi Risiko, Cukupi Enam Kali) combines in-person counseling with e-CINTA BUNDA, a Google Sites-based platform (https://bit.ly/E-CINTABUNDA) developed by the residency team. This platform contains pregnancy e-books, educational videos, digital leaflets, information on pregnancy warning signs, the ANC service schedule at community health centers, an ANC visit calendar organized by trimester, an ANC reminder request form, an attendance confirmation form, and contact information for local midwives. The materials were compiled by the residency team under the guidance of program advisors and field supervisors, and the same version was used in all four sessions (July 20–28, 2026). During the sessions, students guided participants in accessing the platform via a QR code and demonstrated how to use each feature. The same team of facilitators, presentation materials, videos, and sequence of activities were used at all four locations.

Procedure. Each participant attended a single 45-minute session that follows the same session plan (SAP). Following registration, the signing of a written consent form, and a review of the KIA Book to confirm gestational age, the session consisted of an opening (3 minutes),

completion of demographic forms and a pre-test via Google Forms (10 minutes), presentation of the material (10 minutes), discussion and simulation of e-CINTA BUNDA (10 minutes), a post-test using the same questionnaire (10 minutes), and a closing (approximately 2 minutes). Participants completed the questionnaire independently; assistance is limited to reading items aloud upon request, and pre-test answers were not discussed before the post-test.

Students in the Midwifery Master's Residency Program, together with local midwives and health workers, delivered the material interactively using PowerPoint, videos, and handouts, covering the definition and benefits of ANC K6, the visit schedule, nutrition during pregnancy, warning signs and complications, and preparation for childbirth. During the simulation, participants accessed e-CINTA BUNDA on their own smartphones using a link or QR code under the guidance of a facilitator. At the end of the session, participants scheduled their next ANC visit with a midwife and received a handout featuring the platform's QR code. Knowledge and attitudes were not reassessed at a later date, so long-term retention was not evaluated.

Instruments. Respondents self-reported their characteristics and ANC history using a structured questionnaire. The knowledge questionnaire consisted of 12 true–false items regarding signs of pregnancy, the benefits and schedule of prenatal checkups, warning signs, risk factors, and iron tablets (true = 1, false = 0; range 0–12). The attitude questionnaire consisted of 12 five-point Likert scale items regarding prenatal checkups, TT immunization, iron tablets, and delivery risks (scores 1–5; negative items 3 and 5–11 were reverse-scored; range 12–60). Both questionnaires were administered in Indonesian without any changes to the content, and each item in the Google Form was mandatory, ensuring no blank responses.

The knowledge questionnaire was adapted from Rahmaniah [14]; the attitude questionnaire was adapted from Sakinah et al.[15]. Rahmaniah reported that all knowledge items were valid (point-biserial $r > 0.30$; reliability 0.79) and all attitude items were valid (reliability 0.963), without specifying the sample size or the type of coefficient. Internal consistency was not retested in this study's sample.

Total scores were analyzed as continuous variables. For the supplementary analysis only, knowledge scores were categorized as poor (0-6), sufficient (7-9), and good (10-12), following Rahmaniah [14]; attitude scores were not categorized.

Data analysis. Data were analyzed using IBM SPSS Statistics 26. Scores are summarized as mean (SD) and median (Q1–Q3). The outcomes were the paired score differences (posttest minus pretest) for knowledge and attitude. Normality of the paired differences was assessed with the Shapiro–Wilk test, supported by histograms, Q–Q plots, and boxplots. The knowledge differences were approximately normal ($W = 0.976$, $p = 0.179$), whereas the attitude differences deviated from normality ($W = 0.932$, $p = 0.001$; skewness = 0.67); the Kolmogorov–Smirnov test with Lilliefors correction gave knowledge $D = 0.122$, $p = 0.010$, and attitude $D = 0.131$, $p = 0.004$, respectively. Because both scores are bounded summated measures (0–12 and 12–60), the attitude differences were non-normal, and posttest knowledge showed a possible ceiling effect (third quartile = 12), a two-sided Wilcoxon signed-rank test ($\alpha = 0.05$) was applied to both outcomes so that a single test could be used throughout. This test does not assume normality, and the symmetry of the differences was inspected graphically. Asymptotic p-values with tie correction were used; pairs with a zero difference (ties) were excluded from ranking and reported as ties, and $p < 0.001$ is reported where SPSS displays .000. Effect size was calculated as $r = |Z|/\sqrt{N}$ ($N = 72$ pairs) [16] and interpreted as small (0.1), moderate (0.3), and large (≥0.5); the r value describes the magnitude of the pretest–posttest change, not the correlation between knowledge and attitude. The mean change is reported with a t-based 95% confidence interval to show the precision of the estimated change. As a supplementary analysis, knowledge categories (poor, 0–6; sufficient, 7–9; good, 10–12) were cross-tabulated pretest by posttest to show how individual participants moved between categories, and the symmetry of these transitions was tested with the McNemar–Bowker test. This categorical analysis supplements, and does not replace, the paired analysis of total scores. Differences between sessions were not analyzed because the number of participants per session was small.

Ethics. The study was approved by the Research and Innovation Ethics Committee, Universitas Brawijaya (No. 096/EC/KERIS/01/VII/2026; valid 27 July 2026 to 27 July 2027). All participants received verbal and written explanations and then signed a consent form before the pretest. For participants under the age of 20, consent was also obtained from their respective husbands. Participants' names were replaced with codes prior to analysis, and WhatsApp numbers were not included in the analysis data. The data was accessible only to the research

team and stored in a password-protected account.

RESULTS

Recruitment was attendance-based across four sessions: Bintoro, Jumerto, the maternal and child health (MCH) room, and Slawu. Health cadres invited 34 women from the Bintoro and Jumerto registers, but not all attended; recruitment was therefore extended to women attending the pregnancy class in the MCH room and to women in Slawu. The numbers of women present, approached, ineligible, or declining were not recorded at each session; therefore, these numbers and a response rate cannot be reported. In total, 72 women who met the eligibility criteria and gave written informed consent were enrolled. All 72 completed the pretest, the blended e-CINTA BUNDA education, and the immediate posttest in the same session; none withdrew, and no questionnaire had missing responses. All 72 were included in the paired analysis. Their characteristics and baseline ANC profile are presented in Table 1.

Table 1. Participant characteristics and ANC visit profile up to the time of data collection (N = 72)

Characteristic	Category	N	%
A. Participant characteristics			
Maternal Age	<20 years	4	5.6
	20–35 years	57	79.1
	>35 years	11	15.3
Gestational Age	Trimester I (0-12 weeks)	3	4.2
	Trimester II (13-28 weeks)	60	83.3
	Trimester III (>28 weeks)	9	12.5
Parity	Nulliparous	21	29.2
	Primiparous	36	50.0
	Multiparous	15	20.8
Education	Primary School	7	9.7
	Junior High School	28	38.9
	Senior High School	37	51.4
Employment	Employed	4	5.6
	Not Employed	68	94.4

B. Baseline ANC profile			
Facility of first ANC visit (K1)[1]	Midwifery practice at Puskesmas	63	87.5
	Independent obstetrician-gynecologist practice	9	12.5
Previous examination by a general practitioner[2]	Yes	61	84.7
	No	11	15.3
Total ANC visits up to the time of data collection[3]	<6 visits	41	56.9
	≥6 visits	31	43.1

Notes: Values are n (%) with N = 72 as the denominator. ANC = antenatal care. Trimesters were defined by gestational age in weeks at data collection (I, ≤12; II, >12–28; III, >28 weeks). [1] Categories describe the facility of the first ANC visit. [2] Examination by a general practitioner at the primary health care center is reported separately from the facility of the first ANC visit. [3] Total visits represent cumulative ANC visits during the current pregnancy up to data collection. The study did not record visit timing or distribution across gestational age categories. These counts provide descriptive information: <6 visits do not establish non-adherence, and ≥6 visits do not confirm fulfillment of all K6 standard components.

Table 1 presents the characteristics of the 72 participants. Most were aged 20–35 years (57/72, 79.2%) and were in the second trimester of pregnancy (60/72, 83.3%), according to gestational age in weeks at data collection. Half were primiparous (36/72, 50.0%), 21/72 (29.2%) were nulliparous, and 15/72 (20.8%) were multiparous. Slightly more than half had completed senior high school (37/72, 51.4%), and 68/72 (94.4%) were not employed.

At the time of data collection, 63/72 participants (87.5%) reported a midwife clinic or Puskesmas as the facility of their first ANC visit (K1) and 9/72 (12.5%) reported an independent obstetrician-gynecologist practice. Because 60/72 participants (83.3%) were still in trimester II and only 9/72 (12.5%) had reached trimester III, 41/72 (56.9%) having fewer than six cumulative visits does not establish non-adherence to the K6 standard. Likewise, 31/72 (43.1%) with six or more visits does not confirm that all components of the K6 standard were fulfilled. Trimester-specific visit timing and distribution of visits across gestational ages were not analyzed. These counts are therefore descriptive and do not establish whether visits were appropriate for gestational age.

Table 2. Knowledge and attitude scores before and after the intervention, and paired change (N = 72 valid pairs)

Outcome	Measurement	n	Mean (SD)	Median (Q1–Q3)	Observed min - max	Mean change (95% CI)[2]
Knowledge	Pretest	72	5.86 (2.63)	6.00 (4.00–8.00)	1–11	-
	Posttest	72	10.03 (2.02)	10.50 (9.00–12.00)	5–12	-
	Paired change[1]	72	+4.17 (2.40)	4.00 (2.25–6.00)	−2 to +10	4.17 (3.60–4.73)
Attitude	Pretest	72	38.32 (4.58)	39.00 (35.00–42.00)	26–49	-
	Posttest	72	43.47 (6.20)	45.50 (36.00–48.00)	29–56	-
	Paired change[1]	72	+5.15 (4.43)	4.00 (1.00–8.00)	−1 to +18	5.15 (4.11–6.19)

Notes: N = 72 valid pretest–posttest pairs for both outcomes. SD = standard deviation; Q1 and Q3 = first and third quartiles (SPSS weighted average, definition 1); CI = confidence interval. Higher knowledge (0–12) and attitude (12–60; negatively worded items reverse-scored) scores indicate better knowledge and a more favorable attitude. Values are rounded to two decimal places. [1] Change = posttest − pretest, computed for each participant; the mean change is a mean, not a median, and the median in the Change rows is the median of the individual differences. The SD of change was computed directly from the individual differences, not from the pretest and posttest SDs. [2] 95% CI of the mean change, t-based, from the difference scores.

Posttest scores were higher than pretest scores for both outcomes (Table 2). Mean knowledge increased by 4.17 points (95% CI 3.60–4.73) on the 0–12 scale, with the median rising from 6.00 (Q1–Q3, 4.00–8.00) to 10.50 (9.00–12.00). Mean attitude increased by 5.15 points (95% CI 4.11–6.19) on the 12–60 scale, with the median rising from 39.00 (35.00–42.00) to 45.50 (36.00–48.00). Individual changes ranged from −2 to +10 points for knowledge and from −1 to +18 points for attitude, showing heterogeneity in the size of change and a few participants with lower posttest scores. Attitude scores were more variable at posttest (SD 6.20) than at pretest (SD 4.58). The third quartile of posttest knowledge equaled the maximum score (12), suggesting a possible ceiling effect.

Table 3. Wilcoxon signed-rank test and effect size for paired changes (N = 72)

Outcome	Valid pairs (n)	Negative / Positive / Ties	Sum of ranks (negative / positive)	Mean rank (negative / positive)	Z	p-value	r
Knowledge	72	1 / 67 / 4	11.00 / 2335.00	11.00 / 34.85	−7.117	<0.001	0.84
Attitude	72	2 / 63 / 7	16.00 / 2129.00	8.00 / 33.79	−6.918	<0.001	0.82

Notes: Negative = posttest < pretest; positive = posttest > pretest; ties = equal scores (excluded from ranking); 1 + 67 + 4 = 72 and 2 + 63 + 7 = 72. Z and p are from the two-sided Wilcoxon signed-rank test (asymptotic, tie-corrected). The sign of Z depends on the order of the differences and ranks (SPSS reports "based on negative ranks" when positive ranks dominate), so a negative Z does not indicate a decrease. Effect size r = $|Z|/\sqrt{N}$, with N = 72 pairs; r is not a correlation between knowledge and attitude.

The Wilcoxon signed-rank test indicated higher posttest than pretest scores for both outcomes (Table 3). For knowledge, 67 of 72 participants had higher posttest scores, 1 had a lower score, and 4 had unchanged scores ($Z = -7.117$, $p < 0.001$; $r = 0.84$). For attitude, 63 participants had higher posttest scores, 2 had lower scores, and 7 had unchanged scores ($Z = -6.918$, $p < 0.001$; $r = 0.82$). The negative sign of Z reflects the SPSS convention (based on negative ranks) because the positive rank sum exceeded the negative rank sum; it does not indicate a decrease. By Cohen's conventions, $r \geq 0.50$ denotes a large effect.

Table S1. Cross-tabulation of knowledge categories before and after the intervention (N = 72)

Pretest category	Posttest: Poor, n (%)	Posttest: Sufficient, n (%)	Posttest: Good, n (%)	Total, n (%)
Poor	6 (14.3)	12 (28.6)	24 (57.1)	42 (100.0)
Sufficient	1 (4.3)	0 (0.0)	22 (95.7)	23 (100.0)
Good	0 (0.0)	0 (0.0)	7 (100.0)	7 (100.0)
Total	7 (9.7)	12 (16.7)	53 (73.6)	72

Notes: Knowledge categories were defined from the total score (poor, 0–6; sufficient, 7–9; good, 10–12). Values in the body of the table are n (row %, i.e., the percentage of participants in each pretest category); the Total row shows the posttest distribution as a percentage of N = 72. Percentages are rounded to one decimal place. McNemar–Bowker test of symmetry: $\chi^2 = 55.31$, df = 3, $p < 0.001$. Moved to a higher category, 58/72 (80.6%); same category, 13/72 (18.1%); moved to a lower category, 1/72 (1.4%). These percentages sum to 100.1% because of rounding. The test evaluates whether transitions between categories are symmetric; it does not use the order of the categories.

In the supplementary cross-tabulation of knowledge categories (poor, 0–6; sufficient, 7–9; good, 10–12; Table S1), 58/72 participants (80.6%) moved to a higher category, 13/72 (18.1%) remained in the same category, and 1/72 (1.4%) moved to a lower category. The proportion with good knowledge rose from 9.7% to 73.6%, an increase of 63.9 percentage points. The McNemar–Bowker test indicated asymmetry in category transitions ($\chi^2 = 55.31$, df = 3, $p < 0.001$). This categorical analysis supplements but does not replace the paired analysis of total scores (Table 3).

DISCUSSION

Knowledge

The findings of this study demonstrated that the implementation of the e-CINTA BUNDA digital education intervention through the LANCAR K6 Program was associated with an immediate increase in pregnant women's knowledge regarding ANC K6. The mean

knowledge score increased from 5.86 before the intervention to 10.03 immediately afterward, with a statistically significant difference in total knowledge scores based on the Wilcoxon signed-rank test ($p < 0.001$; Tables 2 and 3). In the supplementary categorical analysis, the proportion of women with good knowledge increased from 9.7% to 73.6%, while the proportion with poor knowledge decreased from 58.3% to 9.7% (Table S1). These findings indicate an immediate improvement in knowledge following the combined intervention; however, the independent contribution of e-CINTA BUNDA cannot be determined. [17]

The findings of this study are consistent with previous research on digital interventions in maternal healthcare. Treasa et al. [12] reported significant improvements in pregnant women's knowledge following a four-week mHealth intervention in a quasi-experimental study involving 60 pregnant women in the third trimester. Similarly, Srimulyawati et al. [21], using a one-group pretest–posttest design involving 30 pregnant women, reported an increase in knowledge scores regarding pregnancy danger signs from 8.37 to 11.77 ($p < 0.001$) following WhatsApp-based education. Although both studies support the potential of digital education to improve maternal knowledge, differences in study design, intervention content, and outcome measures should be considered. Meanwhile, Mishra et al. [18] reported increased ANC attendance associated with mHealth interventions (RR = 1.66, 95% CI: 1.07–2.58), representing a behavioral rather than knowledge outcome. Overall, these findings support the potential of digital interventions in maternal healthcare; however, the present study cannot establish the independent effect of e-CINTA BUNDA because it lacked a control group and combined multiple intervention components .

The similarity between these studies and the present study lies in the use of digital technology to provide accessible and repeated maternal health information. However, e-CINTA BUNDA differs from some previous interventions because it integrates several educational and supportive components within a Google Sites platform. In addition to e-books, videos, and digital leaflets, the LANCAR K6 Program included discussion and consultation and assistance in planning subsequent ANC visits. Therefore, the intervention was not limited to one-way information delivery but combined education, interaction, and reinforcement of information [24].

The improvement in knowledge may be associated with the structured, multimodal

educational content of e-CINTA BUNDA, which covered ANC K6 schedules and benefits, pregnancy danger signs, risk factors, nutrition, iron supplementation, complications, and birth preparedness. Presenting information through different digital formats may have facilitated understanding. Although the platform offers the potential for repeated access to educational materials, this mechanism remains hypothetical because repeated use was not verified through usage logs or follow-up assessments [17].

The findings may be interpreted through the Health Belief Model (HBM), which proposes that health related actions are influenced by perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self efficacy. The educational content of e-CINTA BUNDA may hypothetically strengthen perceived benefits and provide cues to action for completing ANC K6 visits. However, HBM constructs were not directly measured in this study therefore, this interpretation remains hypothetical. Furthermore, increased knowledge does not necessarily indicate changes in attitudes or health behaviors, as these outcomes represent distinct dimensions of the health behavior process. Family support may also influence pregnant women's engagement with ANC K6 by providing emotional encouragement and practical assistance in accessing antenatal care services. However, family support was not directly assessed in this study and should therefore be considered a potential contextual factor rather than an established mechanism underlying the observed improvement in knowledge. [25].

The translation of knowledge into positive attitudes and sustained ANC K6 attendance may also be influenced by factors beyond the educational intervention, including family support, financial conditions, accessibility of healthcare services, previous experiences with healthcare, and relationships with health workers. For example, a pregnant woman may understand the importance of ANC K6 but still experience difficulties attending visits because of transportation problems, financial limitations, lack of family support, or previous negative experiences with healthcare services. These factors may act as perceived barriers within the HBM and may influence whether improved knowledge is ultimately translated into health behavior [25].

The findings demonstrated an immediate increase in pregnant women's knowledge regarding ANC K6 following the combined e-CINTA BUNDA intervention through the

LANCAR K6 Program. These findings suggest that digital education may serve as a complementary approach to maternal health education in primary healthcare settings. However, the mechanisms underlying the observed improvement remain uncertain because platform usage, behavioral pathways, and the individual contributions of intervention components were not directly assessed. Furthermore, the observed increase in knowledge does not establish changes in maternal attitudes or actual ANC K6 attendance. In practice, digital education may be complemented by family support, improved access to antenatal services, effective communication with healthcare workers, and strategies to strengthen maternal self efficacy. Future studies should assess knowledge, attitudes, and actual ANC K6 attendance as distinct outcomes and use controlled or longitudinal designs to examine whether knowledge improvements are sustained and associated with changes in antenatal care utilization.

Attitudes

Attitude scores were higher after the e-CINTA BUNDA education than before it. The mean attitude score increased from 38.32 at pretest to 43.47 at posttest, a mean change of 5.15 points (95% CI 4.11–6.19), and the median rose from 39.00 to 45.50 (Table 2). Sixty-three of 72 participants had higher posttest scores, 2 had lower scores, and 7 were unchanged. The Wilcoxon signed-rank test indicated a statistically significant difference between pretest and posttest scores ($Z = -6.918$, $p < 0.001$), with a large effect size ($r = 0.82$; Table 3). These findings indicate that the LANCAR K6 programme, which combined e-CINTA BUNDA with face-to-face education, was associated with more favourable attitudes toward ANC K6 immediately after the session among participating pregnant women.

The present findings align with those reported by Rahman et al., highlighting the potential of digital and mobile health (mHealth) platforms to enhance maternal health literacy, facilitate clinical monitoring, and improve basic maternal health knowledge, thereby supporting the delivery of comprehensive antenatal care [19]. To illustrate, Treasa et al. demonstrated that mHealth technologies effectively sustained the continuity of midwifery services throughout the third trimester [12], whereas Srimulyawati et al. reported a substantial enhancement in pregnant women's awareness of obstetric warning signs through interactive WhatsApp sessions [13]. Additionally, Karamolahi et al. validated the role of mobile platforms in improving baseline health literacy levels among expectant mothers [21].

Although these learning platforms primarily focus on cognitive and literacy benchmarks rather than validating immediate modifications in attitude, they establish the essential groundwork for healthcare utilization. This premise is reinforced by international systematic reviews confirming that mHealth strategies aid in scheduling attendance, ANC tracking, and skilled delivery uptake within low-resource settings [17], [18]. Ultimately, as detailed in a scoping review by Endehabtu et al., these digital healthcare interventions drive effective ANC coverage by blending personalized patient education, targeted behavioral communication, and auxiliary tracking mechanisms [23].

Unlike interventions that depend exclusively on mobile applications, digital messaging, or online support groups, e-CINTA BUNDA incorporated multiple educational and supportive components, including e-books, videos, digital leaflets, face-to-face education, consultations, an antenatal care (ANC) calendar, and planning for subsequent visits. The integration of these elements may have increased the relevance of the information provided and helped participants apply the educational content to their individual pregnancy-care needs. This approach is consistent with the framework proposed by Endehabtu et al., which emphasizes that digital education can be more effective when complemented by interpersonal counselling and practical support, rather than being delivered solely as a standalone information resource [23].

Although the intervention improved maternal knowledge and attitudes, these outcomes do not necessarily translate into behavioural change. Knowledge, attitudes, and health behaviours are interrelated but distinct components of the health-behaviour process. While knowledge provides a foundation for informed decision-making, the translation of positive attitudes into actual health practices may depend on motivation, self-efficacy, social support, and perceived barriers. Consequently, pregnant women may understand the importance of completing the recommended ANC K6 visits and demonstrate positive attitudes towards antenatal care, yet still face difficulties in adhering to the recommended schedule. Consistent with these findings, Ali et al. highlighted that financial constraints, transportation difficulties, long distances to health facilities, competing household responsibilities, and healthcare system barriers may continue to impede regular ANC utilization despite improvements in maternal knowledge and attitudes [24].

Domestic encouragement and institutional interactions heavily dictate maternal

attitudes and their conversion into actual antenatal care (ANC) utilization. When husbands and relatives extend emotional reinforcement, monetary aid, transport logistics, collaborative decision-making, and relief from household chores, a pregnant woman's capacity to seek regular care is significantly amplified. Conversely, a deficiency in home-based backing restricts systematic healthcare access. Beyond these domestic realities, clinical encounters with medical staff operate as a pivotal predictor of service adherence. A scoping review by Mehrtash et al. highlights that intrinsic dimensions of care delivery including clear information exchange, dignified rapport, patient confidentiality, and empathetic midwifery are fundamental to establishing systemic trust. On the other hand, operational bottlenecks such as abrasive communication, excessive wait times, and insensitive treatment drastically lower future care-seeking incentives [25].

The application of the Health Belief Model (HBM) provides a robust framework for interpreting these observations. Instilling knowledge about obstetric danger signs, potential complications, and gestational risk factors directly elevates an expectant mother's perceived susceptibility and severity. At the same time, guidance on the ANC K6 protocol, dietary needs, iron intake, and birth readiness solidifies perceived benefits, while operational assets like the ANC planner and systemic visit tracking serve as essential cues to action. Nevertheless, systemic perceived barriers—including economic restrictions, transit deficiencies, weak familial networks, and negative interactions with clinic staff—frequently obstruct the transition from a positive mindset to consistent attendance. Accordingly, as underscored by Tungaraza and Joho [26], cultivating self-efficacy alongside maternal independence and perceived competence is crucial; pregnant women must possess both the internal confidence and functional capacity required to bypass environmental bottlenecks and fulfill their routine antenatal care requirements [26].

From a practical perspective, these outcomes offer valuable insights for primary care services, suggesting that e-CINTA BUNDA could serve as an effective auxiliary tool to augment standard counseling provided by healthcare volunteers and midwives. To maximize the translation of heightened awareness and favorable attitudes into consistent clinic visits, digital health initiatives as recommended by Endehabtu et al. should ideally be integrated with ongoing personal consultations, spousal or family backing, automated check-up alerts,

logistical scheduling assistance, empathetic communication, and measures targeting economic or transport constraints [23].

Several methodological constraints within this research require careful interpretation. To begin with, the adoption of a single group pre experimental framework, absent a concurrent control group, complicates the ability to separate the direct impact of the digital platform from external confounding factors. Selection bias is another notable concern, as the attendance-based convenience sampling approach was restricted to smartphone-owning pregnant women who volunteered at a single primary care facility. Because the number of women approached was not recorded, the proportion of eligible women who participated could not be determined, and the sample may not represent all pregnant women in the service area. Furthermore, data collection had limitations: the questionnaires were used without local re-validation, assessments were administered immediately after the intervention, which risks testing and recall bias, and self-completion with limited assistance from the team may have influenced responses. Additionally, varying the physical pathways and schedules for the intervention could have introduced contextual variables tied to face-to-face interactions. Lastly, the evaluation focuses solely on short-term shifts in knowledge and attitudes, leaving K6 antenatal care (ANC) attendance, long-term knowledge retention, and maternal-infant clinical outcomes unverified. This issue is compounded by the fact that K6 data is currently logged as a cumulative metric, masking the specific timing and frequency of visits across different gestational stages. To overcome these gaps, subsequent research should implement tracking systems to monitor ANC visits by individual trimester, offering a more precise evaluation of true program compliance and longitudinal attendance patterns.

CONCLUSIONS

The LANCAR K6 program through the e-CINTA digital education initiative, was associated with an increase in pregnant women's knowledge and attitudes regarding ANC K6 at UPTD Puskesmas Banjarsengon. The average knowledge score increased from 5.86 to 10.03, and the average attitude score increased from 38.32 to 43.47. The implementation of e-CINTA BUNDA can serve as a complementary digital education strategy in primary care service. Both knowledge and attitude scores were higher immediately after the session, with similarly large effect sizes; whether attitude changes are sustained, and whether they translate

into ANC attendance, requires longer follow-up. Implementation should be supported by midwives and public health workers, family involvement, reminder mechanisms, and integration with ANC records. However, because this study used a single-group pretest-posttest design and assessed outcomes immediately after the intervention, the findings should not be interpreted as evidence of long-term behavioral change or completion of ANC K6. Future studies should use a controlled design, a longer follow-up period, and ANC attendance outcomes to determine whether improvements in knowledge and attitudes are sustained and translate to higher rates of completing the sixth ANC visit.

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AUTHOR CONTRIBUTIONS

Ayu Candra Seto : Conceptualization, Investigation, Data Curation, Project Administration, Funding Acquisition, Writing - Original Draft. **Noza Loviana** : Data Curation, Formal Analysis, Visualization, Funding Acquisition, Writing - Original Draft, Writing - Review & Editing. **Septia Kusuma Lestari** : Investigation, Funding Acquisition, Writing - Original Draft. **Isnawiyah Madaningrum** : Methodology, Funding Acquisition, Writing - Original Draft, Writing - Review & Editing. **Wafa Aulia Maharany :** Conceptualization, Funding Acquisition, Writing - Original Draft

Aurina Dwi Febriani : Formal Analysis, Funding Acquisition, Writing - Original Draft, Writing - Review & Editing. **Yuseva Sariati :** Methodology and Supervision. **Driana Desy P** : Resources and Project Administration. **Amalia Dwi Shinta :** Investigation. All authors have read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest related to this manuscript and its publication.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed during this study are not publicly available due to ethical considerations and to protect the privacy of participants from a small, identifiable population. All identifiers were replaced with participant codes before analysis and no identifiable participant information is reported in this manuscript. Summary data are provided in the tables and supplementary tables. De-identified data and the questionnaires are available from the corresponding author upon reasonable request, with ethics committee approval.

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