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A Quasi-Experimental Study of Mobile Health Intervention: Measuring the Impact of Android-Based Prenatal Classes on Knowledge and Attitudes of First-Time Mothers in Indonesia

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ABSTRACT

Introduction: Maternal mortality remains a critical global health challenge, with approximately 287,000 pregnancy-related deaths recorded in 2020 (WHO, 2024). In Indonesia, where maternal healthcare access varies significantly, digital interventions may offer scalable solutions. This quasi-experimental study evaluates the effectiveness of an Android-based prenatal education application in improving knowledge and attitudes among first-time mothers in Cimahi, West Java. By comparing app-based learning with traditional methods, we assess whether mobile technology can help bridge gaps in maternal health education and contribute to safer pregnancy outcomes. **Methods**: This quasi-experimental study involved 120 first-trimester primigravida women (60 intervention, 60 control) in Cimahi City. The independent variable was the use of an Android-based prenatal education application; the dependent variables were maternal knowledge and attitudes. Instruments included a validated 20-item knowledge test and a 10-item attitude Likert scale. Data were analyzed using paired and independent *t*-tests, as well as SmartPLS path modeling. **Results**: In the intervention group, knowledge scores increased from 19.8 ± 2.1 to 34.3 ± 2.0, and attitude scores improved from 8.2 ± 1.2 to 13.3 ± 2.8 ($p < 0.001$). The control group showed smaller, non-significant changes (knowledge: 19.5 ± 2.2 to 21.5 ± 2.6; attitude: 7.3 ± 1.5 to 8.3 ± 1.6). Post-test differences between groups were statistically significant ($p < 0.001$). **Conclusion**: The Android-based prenatal education application significantly enhanced the knowledge and attitudes of first-time pregnant women. These findings support the integration of digital education into routine antenatal care services.

INTRODUCTION

Maternal mortality remains a critical global health challenge despite notable progress over the past two decades. In 2023, approximately 700 women died every day due to complications related to pregnancy and childbirth—equivalent to one maternal death every two minutes. Although the global Maternal Mortality Rate (MMR) has declined by 40% since 2000 to 223 deaths per 100,000 live births, 95% of these deaths still occur in low-income countries (WHO, 2025). One of the key contributors to high maternal mortality is the low coverage of antenatal care (ANC). In Indonesia, only about 74.4% of pregnant women undergo regular ANC visits (Tanjung et al., 2024). According to the 2022 Population Census, Indonesia's MMR stood at 189 per 100,000 live births—higher than West Java's rate of 96.89 (792 cases), but lower than Cimahi City's rate of 196.08 per 100,000 in 2021 (Dinkes Cimahi, 2021; Dinkes

Jabar, 2023; Indonesian Health Profile, 2018). These figures highlight systemic barriers including limited healthcare facilities, low public awareness, and geographical or economic constraints, particularly in rural and remote areas (Dewau et al., 2021; Lubis et al., 2022).

In response to these challenges, digital health technology has emerged as a promising solution to improve maternal healthcare (Terry, 2023). E-health and m-health interventions have been widely adopted to deliver accessible, real-time support and health education to pregnant women (Perera, 2012). Mobile devices, online platforms, and telecommunication tools can expand the reach of maternal health programs while reducing the cost of service delivery (Free et al., 2010; A. Sharma et al., 2018). Research shows that these digital tools enhance maternal knowledge and health-seeking behavior, especially in resource-limited settings (Moise et al., 2023). For instance, in Nigeria, mobile-based health promotion significantly improved knowledge and attitudes among pregnant women (Peprah et al., 2019).

Despite their potential, most digital health interventions have focused on broad information dissemination, often lacking structured educational models such as interactive, mobile-based pregnancy classes (P. Sharma & Kaur, 2017; Shi et al., 2021). In Indonesia, the Ministry of Health supports pregnancy classes through Puskesmas, with 93.76% of facilities reportedly offering such programs (Indonesian Health Profile, 2018). However, the effectiveness of these classes—especially when delivered via digital platforms—has yet to be comprehensively evaluated (Fuada & Setyawati, 2015). Moreover, the sustainability and adaptability of traditional classes are challenged by factors like distance, scheduling conflicts, or disruptions such as public health emergencies (Alam et al., 2025; Filip et al., 2022).

This presents show a critical research gap. Although digital platforms have been introduced as tools for maternal education, there is limited empirical evidence on their effectiveness in improving specific maternal health indicators (Ernawati et al., 2022). Previous studies have not sufficiently explored whether mobile applications can effectively replicate or even enhance traditional pregnancy class models (Balasoiu et al., 2021). Understanding how application-based classes influence maternal knowledge and attitudes regarding pregnancy, childbirth, postpartum care, newborn care, and family planning is essential to validating the role of digital health in this context. This study aimed to determine the impact of developing and implementing application-based pregnancy classes on the knowledge and attitudes of expectant mothers, specifically in the areas of pregnancy, childbirth, postpartum care, newborn care, and family planning.

METHODS

Design, Participants, and Sampling

This study employed a quantitative research design with a quasi-experimental approach, utilizing two groups: an intervention group receiving the experimental procedure and a control group receiving alternative health education. The independent variable was the Android-based application for prenatal classes, while the dependent variables were the knowledge and attitudes of primigravida pregnant women. A total of 120 primigravida pregnant women were selected as participants through purposive sampling. These participants were recruited from various healthcare facilities in Cimahi City, including the Central Cimahi, North Cimahi, and South Cimahi Community Health Centers, and three Independent Midwife Practice Locations (TPMB) (Erni, Mutia, and Isti Dariah). Inclusion criteria specified first-trimester primigravida pregnant individuals in Cimahi City (Pure K1), pregnant women with smartphones, and those willing to participate. Primigravida mothers with pregnancy-related complications or comorbidities were excluded. The sample size was determined using the Slovin formula, yielding approximately 120 participants from a total eligible population of 172 pregnant women. The 120 participants were equally divided into a 60-person intervention group and a 60-person control group. A pilot study was conducted before the main data collection to refine the questionnaire and ensure clarity, with pilot participants excluded from the main research to avoid skewed results.

Intervention

The intervention involved an Android-based application for pregnant women's classes, specifically the "E-Pregnancy Pelatihan Kelas Ibu Hamil" (E-Pregnancy Training for Pregnant Women Classes). This application, accessible as a web application at https://pregnancy.mydigiproject.com, served as a learning tool providing information on pregnancy, childbirth, postpartum care, family planning, newborn care, and the Birth Planning and Complications Prevention Program (P4K). The application development followed the System Development Life Cycle (SDLC) using the waterfall process model, encompassing phases of analysis, design, code generation, testing, and support. To use the application, participants registered, created an account, and provided biodata to access information on gestational age and estimated delivery date. Users were then directed to an informed consent page outlining participation conditions and willingness to complete pre- and post-test evaluations. Educational content was delivered through 20-25 minute video modules, made available every three days. A midwife facilitator prepared the videos and delivered health education texts at each material level, following the Guidelines for Pregnant Women Classes. Access to subsequent materials was granted after a three-day window from the previous material's access restriction and after assessment results were entered. Participants could also submit questions for discussion sessions via an "Ask Midwife" menu option. Content validity of the application module was confirmed with Aiken's V coefficients ranging from 0-1. Material and media experts assessed the application, yielding average percentages of 87.5% for material suitability and 86.1% for media quality, categorizing it as "Outstanding value" and "Very worth it" respectively.

Data Collection

The data collection procedure utilized a pre-post-test with control design to determine the impact of application-based lessons on knowledge and attitudes. In the intervention group (n=60), participants underwent a training stage involving account creation and consent for questionnaires. Subsequently, in the pre-intervention stage, they completed a questionnaire before accessing the first material link. During the intervention stage, participants received four video-based class materials, completing a post-test questionnaire after the fourth meeting, with scores automatically accessible by the researcher. The control group (n=60) received standard care, with material provided after three days and a post-test conducted after the fourth material.

Instrument

The research instrument consisted of 24 items derived from health education principles, covering aspects of pregnancy, childbirth, postpartum, newborn care, family planning, and the Birth Preparedness and Complication Prevention Program (P4K). These items assessed both knowledge and attitudes of pregnant women and were distributed across five thematic scales. Validity testing confirmed that all 24 items were valid, with r-count values exceeding the r-table threshold of 0.1966 (df = 100). Reliability testing showed that the instrument was consistent, with Cronbach's alpha values of 0.931 for the "Effect of Android Application," 0.853 for "Knowledge of Pregnant Women," and 0.712 for "Attitudes of Pregnant Women"—all above the accepted minimum threshold of 0.60, indicating that the instrument is reliable for use in research and practice.

Data Analysis

Data analysis was conducted using PLS path modeling and SmartPLS 4.0, with SPSS employed for preliminary analysis, including missing data. The analysis proceeded in three stages: Outer Model Analysis (measurement model), Inner Model Analysis (structural model), and Hypothesis Testing. For the Outer Model, convergent validity was assessed by factor loadings (>0.50) and composite reliability, while discriminant validity was determined by cross-loadings and comparing the square root of AVE values with inter-construct correlations (AVE >0.50 recommended). Reliability was confirmed if composite reliability and Cronbach's alpha values were >0.70. For the Inner Model, model fit tests (Average Path Coefficient (APC) and Average R-squared (ARS) p-value < 0.05; Average Variance Factor (AVIF) < 5) and path

coefficients were evaluated, with R-squared indicating independent variable influence on the dependent variable. Q-square predictive relevance was also assessed. Hypothesis testing involved examining path coefficients and significance levels, with a 5% significance level (p-value < 0.05 leading to rejection of the null hypothesis). Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize data. Normality of data was assessed using the Kolmogorov-Smirnov test, confirming normal distribution for total knowledge score in the intervention group (p-value=0.096), the difference in average knowledge and attitudes in the intervention group (p-value=0.114), and the difference in self-care in the control group (p-value=0.118). Independent t-tests were used for between-group comparisons of continuous variables, and paired t-tests for within-group comparisons.

User Satisfaction

User satisfaction with the Android-based prenatal education application was assessed using a structured evaluation form administered after the intervention. The form measured aspects such as content quality, ease of use, and overall usefulness, with scores categorized into three levels: “Not Enough” for total scores below 60% of the maximum, “Good” for scores between 60%–79.9%, and “Very Good” for scores equal to or above 80%. These categories followed standard digital media evaluation benchmarks to reflect user perceptions of application quality and effectiveness.

RESULTS

Characteristics of Respondents

The research was conducted in three Puskesmas for the control group and in three TPMB for the intervention group. A total of 172 pregnant women participated in the study. Purposive sampling was utilized to select the sample, comprising 120 pregnant women in their first trimester, with a total of 60 participants for the control group and 60 participants for the experimental group.

Table 1. Characteristic of Respondent

Characteristic	Frequency	Percentage (%)
Education		
Elementary School	5	4.2
Junior High School	35	29.2
Senior High School	62	51.6
College	18	15.0
Employment		
Employed	48	40.0
Unemployed	72	60.0
Age		
20–35 years	88	73.3
<20 or >35 years	32	26.7

The majority of respondents had a senior high school education (51.6%), did not work (60%), and were aged between 20–35 years (73.3%), which reflects a generally young and moderately educated population. These characteristics may influence both access to and comfort with digital health tools like mobile applications.

Prenatal Knowledge and Attitudes Before and After Intervention

The study measured knowledge and attitudes toward pregnancy, childbirth, postpartum care, and complication prevention both before and after the intervention. The results are presented in Table 2.

Table 2. Comparison of Knowledge and Attitude Scores (Pre- and Post-Intervention)

Variables	Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	*p*-value (Paired t-test)
Knowledge	Intervention	19.8 ± 2.1	34.3 ± 2.0	< 0.001
	Control	19.5 ± 2.2	21.5 ± 2.6	0.082
Attitude	Intervention	8.2 ± 1.2	13.3 ± 2.8	< 0.001
	Control	7.3 ± 1.5	8.3 ± 1.6	0.073

In the intervention group, the mean knowledge score significantly increased from 19.8 to 34.3, and the mean attitude score rose from 8.2 to 13.3 ($p < 0.001$). These increases contrast sharply with the control group, which exhibited only minor, non-significant gains. This suggests a substantial effect of the Android-based application. The application's effectiveness can be attributed to several key factors: (1) multimedia learning modules that enhanced engagement and retention, (2) flexible, asynchronous access allowing users to learn at their own pace, (3) structured progression and periodic assessments that reinforced learning, and (4) interactive features such as the "Ask Midwife" tool that encouraged deeper understanding. Additionally, the ability to repeat video materials likely benefited users with varying educational backgrounds, particularly those with limited formal schooling. These features collectively supported a more effective and personalized learning experience compared to traditional in-person pregnancy classes.

Effectiveness Evaluation of the Android-Based Prenatal Education Application

To further assess the effectiveness of the intervention, post-test scores were compared between the two groups using *independent t-tests*. The results are shown in Table 3.

Table 3. Post-Test Comparison Between Intervention and Control Groups

Variable	Intervention Mean ± SD	Control Mean ± SD	*p*-value (Independent t-test)
Knowledge	34.3 ± 2.0	21.5 ± 2.6	< 0.001
Attitude	13.3 ± 2.8	8.3 ± 1.6	< 0.001

Post-test knowledge and attitude scores were significantly higher in the intervention group compared to the control group ($p < 0.001$), confirming the application's effectiveness. Several features of the Android-based prenatal class likely contributed to this outcome. The app delivered health information through structured, easy-to-understand video content accessible at the users' convenience, enhancing comprehension and retention. The integration of periodic assessments and interactive tools—such as the "Ask Midwife" feature—encouraged active learning and user engagement. Moreover, the ability to replay materials likely helped reinforce learning, particularly among participants with lower levels of formal education. These pedagogical strengths support the superiority of the application over conventional methods in delivering impactful maternal health education.

Table 4. Correct answer

No	Knowledge item	Pretest		Posttest	
		n	%	n	%
1	Danger signs in the first trimester of pregnancy	24	40.0	55	91.7
2	Benefits of routine antenatal check-ups	22	36.7	53	88.3
3	Nutritious foods for pregnant women	20	33.3	52	86.7
4	Signs of normal labor	25	41.7	54	90.0
5	Postpartum perineal wound care	23	38.3	56	93.3
6	Correct breastfeeding techniques	21	35.0	53	88.3

No	Knowledge item	Pretest		Posttest	
		n	%	n	%
7	Importance of basic immunization for infants	19	31.7	50	83.3
8	Postpartum family planning methods	20	33.3	52	86.7
9	Birth Preparedness and Complication Prevention Program (P4K)	18	30.0	50	83.3
10	Importance of family support during pregnancy	22	36.7	55	91.7
11	Need for rest and physical activity during pregnancy	26	43.3	54	90.0
12	Standard antenatal care procedures by Ministry of Health	24	40.0	56	93.3

Table 4. Attitude answer

No	Attitude item	Pretest		Posttest	
		n	%	n	%
1	I believe early antenatal care is important	20	33.3	46	76.7
2	I feel comfortable consulting midwives through digital platforms	18	30.0	48	80.0
3	I am willing to give birth at a health facility	22	36.7	50	83.3
4	I am committed to attending regular prenatal classes	19	31.7	47	78.3
5	I support the use of mobile applications for pregnancy education	21	35.0	49	81.7
6	I want to learn more about breastfeeding and breast milk	17	28.3	45	75.0
7	I believe family planning is essential after childbirth	20	33.3	48	80.0
8	I want to ensure my baby receives complete immunizations	23	38.3	50	83.3
9	I think it is important to prepare a birth plan (P4K	25	41.7	51	85.0
10	I am confident in caring for my baby after birth	21	35.0	48	80.0
11	I support involving husbands in pregnancy education	19	31.7	46	76.7
12	I believe I can apply the knowledge from the prenatal class in life	22	36.7	49	81.7

Evaluation of an Android-Based Pregnancy Class

User feedback from the intervention group indicated a generally positive experience with the application. As shown in Table 2, 50% rated the app as “very good,” 36.7% as “good,” and 13.3% as “not enough.” These categories were defined during instrument design: “Not enough” reflected users’ perception of low satisfaction and difficulty in use; “Good” represented adequate functionality and learning; while “Very good” indicated high usability and satisfaction. This user satisfaction suggests strong potential for digital applications to support maternal education effectively, particularly when designed with user-centered features and quality content.

Table 6. Results of Intervention Evaluation of Pregnancy Class Android Application Use for Pregnant Women

Assessment Characteristics	n	%
Not Enough	8	13.3%
Good	22	36.7%
Very Good	30	50.0%

DISCUSSION

The findings revealed a significant improvement in knowledge and attitudes among pregnant women who used the Android-based prenatal education application. This suggests not only statistical effectiveness, but also educational impact. The behavior change observed may be understood through the lens of the Social Cognitive Theory (SCT, which emphasizes the importance of observational learning, self-efficacy, and reinforcement. In our study, the video-based modules served as modeling tools, the interactive quizzes and "Ask Midwife" features enhanced self-efficacy, and the immediate feedback mechanisms provided reinforcement. These elements align with SCT constructs, supporting the idea that digital interventions can influence cognitive and behavioral outcomes when they provide structured, engaging, and feedback-rich experiences (Choudhury & Choudhury, 2022; Sener & Cimete, 2016.

Previous studies on digital maternal health interventions (Moise et al., 2023; Vamos et al., 2019) have consistently reported improvements in knowledge and attitudes. However, many lacked a theoretical underpinning. By integrating Social Cognitive Theory, our study provides a clearer mechanism for how behavior change may occur in digital environments. Compared to traditional lecture-based methods, which often assume passive reception of information, our mobile-based approach likely promoted more active learning, self-directed exploration, and experiential reinforcement—key SCT principles. The discrepancy with studies using passive instructional models may thus be due to the absence of these mechanisms of engagement and behavioral modeling.

These findings support the use of m-health tools not only as an alternative delivery method but also as a catalyst for behavior change when designed in accordance with health behavior theories such as SCT. Public health programs should integrate theoretical frameworks into digital intervention design to ensure educational content is not only informative but behaviorally transformative. Policymakers should consider supporting the development and evaluation of theory-driven applications to improve maternal health outcomes more systematically.

Despite its contributions, this study has several limitations. The quasi-experimental design introduces a risk of selection bias, as participants were not randomized. Although efforts were made to match control and intervention groups, unmeasured confounders (e.g., prior exposure to digital health tools, intrinsic motivation could influence results. Additionally, relying on self-reported data may lead to social desirability bias, where participants overreport positive attitudes or knowledge. This potentially inflates the apparent effectiveness of the intervention. The local nature of the sample (limited to Cimahi City also constrains external validity. To mitigate these biases in future research, randomization, blinding of assessors, and triangulation with objective behavioral metrics are recommended.

These findings support the use of m-health tools not only as an alternative delivery method but also as a catalyst for behavior change when designed in accordance with health behavior theories such as SCT. Public health programs should integrate theoretical frameworks into digital intervention design to ensure educational content is not only informative but behaviorally transformative. Policymakers should consider supporting the development and evaluation of theory-driven applications to improve maternal health outcomes more systematically.

CONCLUSION

This study demonstrated that an Android-based prenatal education application significantly improved maternal knowledge and attitudes among first-time mothers. These findings support the integration of mobile health tools into antenatal care (ANC services and midwife training programs to enhance digital health literacy and reach. While promising, the study is limited by its quasi-experimental design, local sample, and reliance on self-reported data, which may affect generalizability and introduce bias. Future research should address these limitations and explore the application's long-term impact and scalability. As digital health becomes more prominent, ensuring equitable access to mobile interventions across diverse populations will be critical for maximizing public health benefits.

Author's Contribution Statement: The authors confirm contribution to the paper as follows: *Erni Hernawati* conducted the literature review, collected data, and implemented the research intervention. *Datin Dr. Hafizah* developed the research instruments and modules. *Nisa Nambian* was responsible for the research methodology and analysis. *Sofa Nurul Hidayati* drafted the manuscript.

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How To Use The Apps:
https://docs.google.com/document/d/1zAil7cda5SIJeCdjY7uJEFGhfCCwlUpu/edit?usp=drive_link&ouid=106647288176058502329&rtpof=true&sd=true

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