Jurnal Promkes: The Indonesian Journal of Health Promotion and Health Education
Vol. 13 No. 2 (2025) 230-238 *doi: 10.20473/jpk.V13.I2.2025.230-238*

# *Digital Transformation in Antenatal Care in Indonesia: The Effectiveness of The 'Bundaqusehat' Application*

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## ABSTRACT

***Background**: Antenatal care (ANC) is recognized as an essential component of maternal health aimed at reducing maternal and fetal morbidity and mortality. Antenatal care has undergone a digital transformation through mobile health (mHealth), but research specifically discussing mHealth solutions for antenatal care in Indonesia is still limited. **Purpose**: This study aims to evaluate the effectiveness of the web-based application Bundaqusehat in supporting antenatal services. **Methods**: The research design was a quasi-experimental pretest-posttest with a control group, and the research participants included 30 pregnant women from two Health Centers (intervention group) and one Health Center (control group). Data collection was conducted using a structured questionnaire administered before and after the intervention. Statistical analysis used the T-test, with a significance set at $p < 0.05$. **Results**: The analysis showed significant improvements in pregnant women's knowledge ($p = 0.001$), satisfaction ($p = 0.002$), attitude ($p = 0.002$), behavior ($p = 0.001$), adherence to iron tablet consumption ($p = 0.030$), and fetal movement monitoring ($p = 0.041$). The intervention group showed greater adherence to the recommended antenatal practices than the control group. **Conclusion**: The Bundaqusehat application demonstrates significant potential in enhancing the quality of antenatal care, highlighting the critical role of digital health solutions. Future research should focus on refining and optimizing these digital interventions to maximize their positive impact.*

***Keywords**: Antenatal Care, Midwives, Pregnant Women, Service Quality, Web-Based Apps.*

## INTRODUCTION

In 2020, complications related to pregnancy and childbirth caused around 800 pregnant women to die every day worldwide, which is equivalent to one death every two minutes (Organization, 2023). This incident mostly occurred in low- and middle-income countries (LMIC), which had a maternal mortality ratio (MMR) of 239 deaths per 100,000 live births, compared to developed countries with an MMR of 12 deaths per 100,000 live births (Amin, Haswita and Nuraeni, 2025). In Indonesia, the Maternal Mortality Rate (MMR) is 189 deaths per 100,000 and is far from the Sustainable Development Goals (SDGs) target in 2023, which is 70 deaths per 100,000 live births (Afifah *et al.*, 2022). According to the World Health Organization, maternal death is the death of a woman that occurs during pregnancy or within 42 days after delivery caused by factors related to the pregnancy and its management, except those caused by accidents or other external events (Sutrisno and REI, 2022).

The main causes of maternal death in Indonesia are obstetric complications, such as hemorrhage and hypertension during pregnancy. Hemorrhage accounts for 28-32% of maternal deaths, while hypertension, including eclampsia, contributes to 24-25% (Sari and Nurwati, 2023); (Novitasari, 2022); (Podungge *et al.*, 2023). Other significant contributors include infections, obstructed labor, and unsafe abortions (Sari and Nurwati, 2023); (Novitasari, 2022). Non-obstetric causes, such as chronic diseases and infections, also contribute to approximately 32% of maternal deaths (Novitasari, 2022).

Antenatal care (ANC) is globally recognized as an important aspect of maternal health, aiming to reduce maternal morbidity and mortality. ANC provides prevention, health promotion, screening, and diagnosis of diseases in pregnant women. Pregnancy complications can be detected during pregnancy with


Received: 15-11-2024, Accepted: 19-12-2024, Published Online: 03-09-2025

intensive monitoring at antenatal care visits (Morón-Duarte *et al.*, 2019). To improve ANC services, the Indonesian government has introduced several initiatives, including the 'Making Pregnancy Safer' program, which focuses on encouraging husbands to actively support their wives during pregnancy and childbirth (Rani, 2022). The frequency of ANC visits is crucial in reducing maternal mortality risk, as regular ANC is associated with better knowledge and management of high-risk pregnancies (Sari and Nurwati, 2023); (Komariyah, 2009).

Digital transformation in healthcare services, particularly through mobile health (mHealth) for antenatal services, marks a significant shift in how healthcare is delivered and accessed. mHealth applications, which can be easily downloaded to smartphones, play a pivotal role by providing remote access to healthcare services, thus enhancing convenience and accessibility for pregnant women (Eşiyok, Uslu Divanoğlu and Çelik, 2023); (Vidal-Alaball *et al.*, 2023) this transition faces challenges such as reliance on legacy technology, regulatory issues, and security concerns (Sushanta et al., 2023).

Previous studies have shown that mHealth interventions have significantly improved the uptake and quality of ANC services in various LMICs, including Pakistan, Tanzania, Nigeria, and Ghana. These interventions have enhanced the frequency of ANC visits and adherence to WHO recommendations, leading to better maternal and fetal health outcomes (Jabeen and Mohammad, 2023); (Nuhu *et al.*, 2023); (Osanyin *et al.*, 2022); (Paduano *et al.*, 2022). In West Jakarta, maternal health conditions face significant challenges with high maternal mortality rates. The implementation of mHealth has shown promise in improving the quality of ANC services, ensuring continuity of care, and addressing issues faced by pregnant women (Fatimah, Erwandi and Prasetyo, 2022); (Herwansyah *et al.*, 2022); (Delmaifanis, Siregar and Prabawa, 2021); (Susanti *et al.*, 2022).

Despite these advancements, there have been limited studies specifically addressing the integration of comprehensive mHealth solutions tailored for antenatal care in Indonesian settings. Most existing research focuses on specific aspects of maternal health or isolated features of mHealth applications without evaluating a holistic solution. Additionally, many studies highlight the challenges of implementing these technologies, such as technological barriers, limited digital literacy, and the need for supportive infrastructure.

Therefore, this research intends to fill this gap by evaluating the effectiveness of the web-based application Bundaqusehat in supporting antenatal services provided by midwives in Indonesian settings. The web-based application Bundaqusehat provides various assistance that can help with antenatal services. Unlike previous studies that often address isolated features, Bundaqusehat integrates multiple functionalities, including digital health records, risk detection, visit reminders, health promotion, and teleconsultation. Bundaqusehat also provides a fetal movement monitoring feature that helps pregnant women monitor their fetus' movements. This research aims to enhance service quality, promote maternal health, and improve knowledge, satisfaction, and compliance among pregnant women with antenatal services.

## METHODS

This study employed a quasi-experimental pretest-posttest design with a control group to evaluate the effectiveness of the web-based application Bundaqusehat for antenatal services. The research was conducted from March to September 2022. Participants in this study were 60 pregnant women at the Community Health Center with the number of respondents in each group being 30 pregnant women. The intervention group used the Bundaqusehat application, whereas the control group received standard antenatal care without the use of the application. The Bundaqusehat application features several functionalities, including health records, risk detection, reminders, health promotion, Q&A, teleconsultation, and fetal movement monitoring.

Data collection involved administering structured questionnaires before and after the intervention to measure changes in knowledge, satisfaction, attitude, behavior, adherence to iron tablet consumption, and fetal movement monitoring. The


Received: 15-11-2024, Accepted: 19-12-2024, Published Online: 03-09-2025

questionnaire has been tested for validity and reliability before being used in the study to ensure the accuracy and consistency of the data collected. The results confirmed that the questionnaire was both valid and reliable.

The pretest established baseline data, while the post-test assessed the impact of the intervention. The T-test was used in statistical analysis to compare pre-test and post-test results between the intervention and control groups, with the significance level set at $p < 0.05$. This approach aligns with recent methodological recommendations for evaluating health interventions (Creswell and Creswell, 2017). The research received ethics approval from the Research and Community Service Ethics Commission under approval number Ket-108/UN2.F10.D11/PPM.00.02/2022.

## RESULTS AND DISCUSSION

### Characteristics of Respondents

The characteristics of the respondents consisted of 60 pregnant women with 30 participants each in both groups. The variables studied in the characteristics of respondents included age, education, employment, and pregnancy history of women.

**Table 1**. Characteristics of Respondents

| Variable | Intervention Group | | Control Group | | p-value |
|---|---|---|---|---|---|
| | n | % | n | % | |
| **Age** | | | | | |
| 18-20 Years | 5 | 16.7 | 4 | 13.3 | 0.313 |
| 21-35 Years | 18 | 60 | 23 | 76.7 | |
| > 35 Years | 7 | 23.3 | 3 | 10 | |
| **Education** | | | | | |
| Elementary School | 2 | 6.7 | 4 | 13.3 | 1.00 |
| Junior High School | 12 | 40 | 10 | 33.3 | |
| Senior High School | 13 | 43.3 | 15 | 50 | |
| University | 3 | 10 | 1 | 3.3 | |
| **Occupation** | | | | | |
| House Wife | 22 | 73.3 | 21 | 70 | 0.92 |
| Employee | 5 | 16.7 | 5 | 16.7 | |
| Other | 3 | 10 | 4 | 13.3 | |
| **Pregnancy** | | | | | |
| 1 | 8 | 26.7 | 8 | 26.7 | 1.00 |
| 2 | 10 | 33.3 | 13 | 43.3 | |
| 3 | 6 | 20 | 7 | 23.3 | |
| 4 | 6 | 20 | 2 | 6.7 | |

In the intervention group, most pregnant women were aged 21-35 years with a percentage of 60% and in the control group 76.7%. Most respondents had a history of their last education at the high school level with a percentage of 13.3% in the intervention group. Similar to the intervention group, the majority of respondents in the control group were also at the high school level with a higher percentage of 15%. In the employment category, the majority of respondents in the intervention group were housewives with a percentage of 73.3%, and in the control group with a lower percentage of 70%. The majority of respondents in the intervention group were in their 2nd pregnancy with a percentage of 33.3% and in the control group with a larger percentage (43.3%). Based on the characteristics of the variables age, education, occupation, and pregnancy, the distribution in the two groups did not show any significant differences.

### Knowledge, Satisfaction, Attitude, and Behavior of Pregnant Women

Table 2 shows that the knowledge of pregnant women in the intervention group had an average pretest of 19.70 and a posttest of 26.86, indicating an increase after the intervention. The results of the analysis obtained a p-value of 0.001 (> 0.05) on the knowledge of pregnant women in the intervention group, indicating a significant increase in the knowledge of pregnant women after being given an intervention using the web-based application Bundaqusehat.


Received: 15-11-2024, Accepted: 19-12-2024, Published Online: 03-09-2025

**Table 2.** Mean Scores and p-value of Knowledge, Satisfaction, Attitude, and Behavior of Pregnant Women in Control and Intervention Groups

| Variable | Time | Mean | SD | p-value | Effect Size |
|---|---|---|---|---|---|
| Knowledge (Intervention) | Pre | 19.70 | 1.80 | 0.001 | 2.681 |
| | Post | 26.86 | 3.32 | | |
| Knowledge (Control) | Pre | 20.00 | 2.00 | 0.083 | |
| | Post | 20.20 | 2.33 | | |
| Satisfaction (Intervention) | Pre | 71.60 | 9.41 | 0.002 | 0.481 |
| | Post | 76.20 | 9.68 | | |
| Satisfaction (Control) | Pre | 71.60 | 9.41 | 0.039 | |
| | Post | 71.80 | 9.68 | | |
| Attitude (Intervention) | Pre | 24.76 | 3.13 | 0.002 | 0.481 |
| | Post | 26.86 | 3.32 | | |
| Attitude (Control) | Pre | 26.10 | 3.82 | 0.003 | 0.198 |
| | Post | 26.80 | 3.19 | | |
| Behavior (Intervention) | Pre | 34.13 | 4.22 | 0.001 | 0.477 |
| | Post | 36.06 | 3.85 | | |
| Behavior (Control) | Pre | 35.10 | 3.82 | 0.005 | 0.304 |
| | Post | 36.26 | 3.79 | | |

This research indicates a significant increase in knowledge scores among pregnant women in the intervention group after using the web-based application. The effect size of 2.681 suggests a substantial impact, underscoring the application's effectiveness in enhancing maternal knowledge. The control group, however, showed minimal change, highlighting the importance of the digital intervention in improving antenatal education. This study's findings align with previous research, showing that digital interventions can significantly improve maternal health knowledge and outcomes. Digital ANC and PregeX have demonstrated success in addressing mental health and promoting behavioral changes, respectively (Janani & Prabha, 2023; (Tendean, 2023).

Features that support increasing knowledge are health promotion materials displayed in the form of videos and images/leaflets that provide important information related to pregnancy. Q&A also plays a role because cases or complaints asked by participants, it is possible that other pregnant women also experience the same thing. Researchers believe that the consistent positive outcomes across different applications and settings emphasize the need for integrating digital strategies into antenatal care to enhance maternal knowledge effectively. This integration is important to improve maternal and fetal health outcomes.

The intervention group reported a significant increase in satisfaction, showing a moderate improvement in their perception of the quality of antenatal care. On the other hand, although the data showed a slight increase in satisfaction in the control group, it was not significant. This could be due to different factors, such as the facilities owned by health facilities and the staff's attitude. This is also supported by the medium effect size value which highlights the added value of web-based applications in increasing patient satisfaction. These findings align with previous research showing the efficacy of digital tools in antenatal care. For example, the 'SwasthGarbh' app improves the quality of antenatal care and health outcomes (Sharma *et al.*, 2022). Similarly, the PregeX app was found to be effective in promoting healthy practices during pregnancy (Janani & Prabha, 2023). In addition, telehealth interventions have effectively managed mental health problems in pregnant women, which is important for maternal and fetal well-being as a whole (Tendean, Dewi and Wirasto, 2021). These results highlight the potential of digital applications to significantly enhance patient satisfaction and care quality in antenatal settings. Future research should optimize these digital interventions to maximize their impact.

The average pretest score of the attitude of pregnant women towards antenatal care in the intervention group was 24.76 and the posttest score was 26.86, indicating an increase after the intervention. Meanwhile, in the control group, the average pretest and posttest


Received: 15-11-2024, Accepted: 19-12-2024, Published Online: 03-09-2025

scores were not much different. The results of the analysis obtained a p-value of 0.002 (<0.05) which indicates a significant increase in the attitude of pregnant women towards maternal services after providing the intervention.

The intervention group showed significantly improved attitudes post-intervention, compared to the control group, indicating a more pronounced positive impact on pregnancy care attitudes. The application provided accessible, reliable, and personalized information, enhancing pregnant women's knowledge and confidence. Digital interventions like health education apps have proven effective in improving self-care and preventive measures knowledge during the COVID-19 pandemic (Setyowati *et al.*, 2022). For example, apps improving nutritional knowledge about chronic energy deficiency (Lestari *et al.*, 2021) and supporting pregnancy and parenting (Deave *et al.*, 2019) significantly boosted maternal attitudes and behaviors, underscoring their public health potential.

The average pretest behavior score in the intervention group was 34.13, while the posttest score was 36.06. Statistical analysis using the t-test showed a significant increase in the behavior of pregnant women towards maternal services after receiving intervention with a p-value of 0.002 (<0.05).

Both groups showed significant behavioral improvements, with the intervention group demonstrating a larger effect size compared to the control group. This highlights the intervention's effectiveness in promoting better childbirth-preparatory behaviors. Mobile health (mHealth) applications enhance pregnant women's health knowledge and behavior. For instance, the Baby Buddy app increased first-time mothers' confidence and healthcare communication (Deave *et al.*, 2019). The Mobile for Mothers app improved maternal health practices among rural Indian women (Choudhury and Choudhury, 2022). Similarly, mHealth apps showed potential in promoting positive behaviors like weight management and dietary improvements (Musgrave *et al.*, 2019), as evidenced by increased maternal health knowledge and dietary diversity in Maharashtra (Rooshenas *et al.*, 2022) and improved self-care among working Korean pregnant women (Lee, Choi and Jung, 2022). Researchers believe these technological solutions should be integrated into standard prenatal care to enhance maternal health outcomes globally.

**Adherence to Iron Tablet Consumption and Fetal Movement Monitoring**

Table 3 presents the level of compliance with iron tablet consumption among pregnant women in both groups. In the intervention group, 27 respondents (90%) always consumed iron tablets, while 3 respondents (10%) consumed them frequently. Meanwhile, in the control group, 19 respondents (63.3%) always consumed iron tablets. The analysis revealed a p-value of 0.030 (<0.05), showing a significant increase in adherence to iron tablet consumption.

**Table 3.** Adherence to Iron Tablet Consumption and Fetal Movement Monitoring of Pregnant Women in Control and Intervention Groups

| Group | Often | | Always | | Total | p-value | OR |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | | | |
| **Iron Tablet Consumption** | | | | | | | |
| Control | 11 | 36.7 | 19 | 63.3 | 30 | 0.030 | 5.211 (91.278-21.237) |
| Intervention | 3 | 10 | 27 | 90 | 30 | | |
| **Fetal Movement Monitoring** | | | | | | | |
| Control | 12 | 40 | 18 | 60 | 30 | 0.041 | 4.33 (1.2-15.6) |
| Intervention | 4 | 13.3 | 26 | 86.7 | 30 | | |

The intervention group showed higher adherence to iron tablet consumption, indicating a strong link between the intervention and improved adherence. Technological interventions, such as mobile apps and SMS reminders, significantly enhance compliance in taking iron tablets, addressing iron deficiency


Received: 15-11-2024, Accepted: 19-12-2024, Published Online: 03-09-2025

anemia in pregnancy. For example, SMS reminders improved knowledge and adherence among pregnant women (Prihanti *et al.*, 2022), while phone call reminders increased compliance and hemoglobin levels (Sontakke *et al.*, 2022). The Pemitasi app also boosted knowledge and compliance regarding anemia (Fertimah, Widyawati and Mulyani, 2022). These findings underscore the critical role of technology in improving iron supplementation adherence and reducing anemia risks. Researchers believe that integrating such technological solutions into standard prenatal care could substantially improve maternal health outcomes and should be prioritized in healthcare strategies.

The level of compliance of pregnant women in monitoring fetal movements in both groups showed that 26 respondents (86.7%) always monitored their fetal movements and 4 respondents (13.3%) monitored them periodically in the intervention group. In the control group, 18 respondents (60%) always monitored their fetal movements. The analysis revealed a p-value of 0.041 (<0.05), indicating a significant increase in adherence to fetal movement monitoring. The intervention group demonstrated significantly higher adherence to fetal movement monitoring, underscoring the web-based application's effectiveness.

Mobile applications improve compliance in monitoring fetal movements by addressing forgetfulness and lack of proper counting knowledge, crucial for preventing stillbirth (Skalecki *et al.*, 2023); (Yudianti *et al.*, 2022). For example, the "Kick Count" app helps women track fetal movements daily, enhancing familiarity and consistency (Yudianti *et al.*, 2022). Digital health solutions increase maternal awareness and timely reporting of decreased fetal movements (DFM) (Skalecki *et al.*, 2023). However, user engagement remains challenging, influenced by education, income, and insurance (Brusniak *et al.*, 2020). Researchers believe that integrating advanced features like multi-point IMU sensing can enhance accuracy and user compliance, ultimately improving maternal and fetal health outcomes (Du *et al.*, 2021); (Zikri, Purbohadi and Kurnianti, 2021). Integrating such technologies into standard prenatal care practices is crucial for enhancing overall pregnancy monitoring and health outcomes.

Several studies have highlighted various applications with different purposes, often used separately from antenatal care services. The Bundaqusehat application offers comprehensive features and is integrated into antenatal care by midwives, making it the main novelty of this study. This application benefits both midwives and pregnant women. To date, government-developed applications are generally designed to facilitate healthcare providers, while applications created by private entities or the community are not directly connected to healthcare providers or facilities. As a result, the health information or promotion received by pregnant women does not come directly from healthcare professionals, and healthcare providers cannot effectively monitor the condition of pregnant women.

Increasing knowledge, attitudes and behavior of pregnant women will greatly affect the habits of pregnant women in pregnancy care and their responses in dealing with various problems or complaints during pregnancy. This positive behavior will have an impact on the health of pregnant women and the outcome of their pregnancy.

Developing the web-based Bundaqusehat application offers a unique advantage over similar applications in Indonesia. This web-based platform is highly suitable for Indonesia’s diverse conditions, as users, especially pregnant women or midwives, do not need to download the application. This allows it to be accessed on various devices, from simple to advanced ones, without relying on memory capacity. This aligns with previous qualitative research findings, which revealed that people are reluctant to use applications due to insufficient memory on their devices (Delmaifanis, Siregar and Nur, 2023).

Although the Bundaqusehat application is not the only factor that causes increased knowledge, changes in attitudes, and compliance, other factors include direct health education by officers and other sources of information. However, ANC equipped with the Bundaqusehat application results in much better satisfaction and behavioral changes (Masoi and Kibusi, 2019); (Murthy *et al.*, 2020). For digital health implementation to run well, the government needs to


Received: 15-11-2024, Accepted: 19-12-2024, Published Online: 03-09-2025

complete infrastructure throughout Indonesia and improve digital capabilities for officers and the community.

**Strengths and limitations of this study**

The Bundaqusehat application is ideal for supporting digital transformation in antenatal care services due to its comprehensive features and ability to facilitate direct interaction between pregnant women and midwives or doctors. This enhances pregnant women's trust in the information provided while preventing the spread of false information often encountered on social media. This application addresses time constraints for healthcare providers in delivering health education, making antenatal services more effective. However, this study's limitations are that it was conducted in Jakarta, where the infrastructure is more advanced, internet connectivity is reliable, Wi-Fi access is widely available, and digital literacy among the population is generally high. This significantly differs from conditions in remote areas in Indonesia, which still face challenges in access to technology and connectivity. In addition, the relatively small sample size and relatively short intervention time are also limitations. Therefore, broader trials and longer intervention times are needed in the future.

## CONCLUSIONS

The study's findings underscore the substantial impact of digital interventions on maternal health knowledge, satisfaction, attitudes, behaviors, and adherence to antenatal care practices. The significant increase in knowledge scores and patient satisfaction in the intervention group compared to minimal changes in the control group highlights the effectiveness of web-based applications in enhancing antenatal education. Improvements in attitudes and behaviors towards pregnancy care, along with higher adherence to iron tablet consumption and fetal movement monitoring, further support the utility of digital tools in promoting healthy practices during pregnancy. These results align with existing research demonstrating the efficacy of digital applications in improving maternal and fetal health outcomes. Integrating these technological solutions into standard prenatal care is crucial for optimizing maternal health globally, addressing both mental and physical health needs. Future research should focus on refining and optimizing these digital interventions to maximize their positive impact, ensuring accessibility and effectiveness for diverse populations. This study emphasizes the transformative potential of digital strategies in advancing public health and enhancing antenatal care quality.

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Received: 15-11-2024, Accepted: 19-12-2024, Published Online: 03-09-2025