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# The Impact of Android-based Pregnancy Education and Care on Enhancing Maternal Health Behavior

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**ABSTRACT** The COVID-19 pandemic significantly impacted maternal health services, leading to a global increase in maternal mortality rates (MMR), with East Java experiencing a rise to 234.7 per 100,000 live births in 2021, although Surabaya recorded a lower rate of 42.33 per 100,000 live births. This concerning trend highlights the critical need to enhance pregnant women's knowledge, attitudes, and practices regarding pregnancy care, especially amidst public health crises that limit traditional healthcare access. This quantitative quasi-experimental study, utilizing a one-group pretest-posttest design, aimed to investigate the effectiveness of an Android-based educational and care application in improving the behavior of 51 pregnant women at the Krembangan Selatan Health Center in Surabaya, selected via purposive sampling. Data collected from February to April 2023 through questionnaires were analyzed using univariate and bivariate methods, with the Wilcoxon signed-rank test revealing statistically significant improvements in knowledge ($p=0.005$), attitude ($p=0.008$), and actions ($p=0.019$), all below the $\alpha=0.05$ significance level. These results indicate that the Android-based application effectively influenced pregnant women's understanding, disposition, and practices related to pregnancy care. Consequently, the study concludes that Android-based educational and treatment applications are valuable tools for improving the behavior of pregnant women, recommending their use to enhance overall pregnancy outcomes, particularly when conventional healthcare access is restricted.

**INDEX TERMS** application, pregnant women, behavior, maternal health, education.

## I. INTRODUCTION

Maternal health continues to be a vital concern in global public health, with maternal morbidity and mortality serving as critical indicators of healthcare system effectiveness [1], [2]. Despite significant advancements, many regions particularly low and middle income countries struggle to reduce maternal mortality rates (MMR) due to limited access to quality antenatal care, inadequate health education, and socio cultural barriers [3], [4]. According to the World Health Organization, approximately 295,000 maternal deaths were reported worldwide in 2017, with preventable causes accounting for a substantial proportion [2], [5]. Therefore, innovative, scalable, and culturally appropriate interventions are needed to improve maternal health outcomes effectively.

The proliferation of digital technologies, particularly mobile health (mHealth), offers promising avenues for enhancing maternal health education and behaviors [6], [7]. With the widespread use of smartphones, Android-based applications have become accessible tools for delivering pregnancy-related information, health monitoring, and behavioral interventions [8], [9]. Recent research illustrates that such digital platforms can improve pregnant women's knowledge, attitudes, and practices related to pregnancy care, contributing to better health behaviors and outcomes [10], [11], [12]. For example, studies reveal that tailored pregnancy education applications can positively influence adherence to antenatal visits, nutritional practices, and health monitoring activities [13], [14].

However, despite these advances, significant gaps persist in existing literature. Many mobile applications are developed without sufficient cultural adaptation or user engagement strategies, limiting their effectiveness across diverse populations [15], [16]. Moreover, most studies focus primarily on short-term knowledge gains, with limited evidence concerning sustained behavioral changes such as attitude shifts and actual health practices [17], [18]. Additionally, the COVID-19 pandemic has further disrupted routine maternal healthcare services, amplifying risks associated with limited access and information gaps, while underscoring the necessity for remote and reliable educational solutions [19], [20]. There remains a lack of rigorous experimental data on the efficacy of Android based pregnancy applications in fostering meaningful behavioral change under pandemic conditions.

Recent efforts in digital health emphasize integrating evidence-based behavior change techniques with culturally relevant content to maximize impact [21], [22]. Despite these innovations, high-quality, controlled studies evaluating the impact of such applications on maternal behaviors particularly

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during pandemics are scarce. Addressing this gap is crucial to inform policy, optimize application design, and effectively integrate digital tools into maternal health programs.

This study aims to evaluate the impact of an Android-based pregnancy education and care application on improving maternal health behaviors among pregnant women. It assesses how digital interventions influence not only knowledge but also attitudes and practices related to pregnancy management within the context of COVID-19 restrictions. The study provides the following contributions:

1. Empirical evidence on the effectiveness of a culturally tailored, Android-based pregnancy education app in enhancing maternal health behaviors.
2. A comprehensive evaluation encompassing knowledge, attitude, and practice components, offering insights into behavioral change mechanisms.
3. Recommendations for integrating digital health solutions into maternal health programs, especially under constraints posed by pandemic scenarios.
4. A methodological framework for future research assessing mHealth interventions in diverse settings.

The remainder of this paper is organized as follows: Section I reviews relevant literature on digital health interventions in maternal care. Section II describes the research methodology, including design, sampling, and data analysis. Section III presents the results. Section IV discusses the findings in light of existing research and theoretical frameworks. Finally, Section V concludes with policy implications, limitations, and directions for future research.

## II. METHODS

This research employed a quantitative quasi-experimental design to evaluate the impact of an Android-based pregnancy education and care application on maternal health behaviors. The study was conducted at the Krembangan Selatan Health Center in Surabaya during the 2022-2023 period. This methodological approach was chosen to rigorously assess the effectiveness of the intervention while maintaining practical feasibility within the targeted population.

### A. STUDY DESIGN

The study utilized a one-group pretest-posttest design, a subtype of quasi-experimental research, to examine changes in maternal knowledge, attitudes, and behaviors following exposure to the mobile application intervention. This design involves measuring the outcome variables prior to (pretest) and after (posttest) the intervention on the same set of participants. Unlike randomized controlled trials (RCTs), the absence of a control group in this design was acknowledged; nonetheless, it provides valuable insights into the intervention's potential effects [23], [24].

### B. STUDY POPULATION AND SAMPLING

The total population comprised 308 pregnant women attending the Krembangan Selatan Health Center over the specified period. A purposive sampling method was employed to select participants who met predetermined inclusion criteria, ensuring relevance and data quality. The inclusion criteria entailed: (1) possessing a KIA booklet to confirm pregnancy status, (2) possessing functional Android devices capable of installing and operating the application, and (3) voluntarily willing to participate. Exclusion criteria included: (a) women without Android smartphones, (b) repetitive absence during data collection sessions, (c) relocating during the study, and (d) women who had already delivered during the research timeline. According to the inclusion and exclusion parameters, a sample of 51 pregnant women was obtained, representing approximately 16.6% of the original population. The sample size was determined based on statistical power calculations ensuring the detection of meaningful differences with a confidence level of 95% and a power of 80% [25].

### C. PROCEDURES AND INTERVENTION

Prior to the intervention, participants completed a baseline assessment to determine their initial level of knowledge and attitudes regarding pregnancy and maternal health. Data collection tools included structured questionnaires validated for content and construct validity within local contexts [26]. Following the pretest, participants were introduced to the Android-based pregnancy education and care application, specifically designed to provide comprehensive information on maternal health, nutrition, antenatal appointments, and self-care practices. The application incorporated user-friendly interfaces, multimedia content, and interactive modules aligned with national health guidelines. The intervention period lasted four weeks, during which participants were instructed to engage with the application regularly. Engagement was monitored remotely through built-in usage logs, and participants received periodic reminders and motivational messages to encourage consistent utilization [27].

### D. DATA COLLECTION AND INSTRUMENTS

Post-intervention, the same questionnaires used during pretest administration were re-administered to measure shifts in knowledge and attitudes. The primary variables of interest included maternal knowledge levels, attitude scores, and reported health behaviors such as antenatal care attendance, nutritional compliance, and personal hygiene practices. Cronbach's alpha coefficients for the questionnaires exceeded 0.80, indicating good internal consistency [28].

### E. DATA ANALYSIS

Data were analyzed using both univariate and bivariate statistical methods. Descriptive statistics summarized demographic characteristics, while inferential analysis employed the Wilcoxon signed-rank test to identify significant differences between pretest and posttest scores, appropriate for ordinal data and non-parametric distributions [29]. A significance level of $p < 0.05$ was adopted as the threshold for statistical significance. Data analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). To account for potential confounding variables, stratified analyses based on age, education level, and parity were conducted [30].

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### F. ETHICAL CONSIDERATIONS

The study protocol was reviewed and approved by the Institutional Ethics Committee of the health center and adhered to the principles of ethical research involving human subjects. Participants provided written informed consent prior to participation, with assurances of confidentiality and the right to withdraw at any time without repercussions.

### G. LIMITATIONS AND DELIMITATIONS

While the one-group pretest-posttest design facilitates rapid assessment of intervention efficacy, it inherently limits the ability to control for external confounding factors such as maturation, history effects, or other concurrent health education initiatives [31]. Future studies are recommended to incorporate randomized controlled designs to strengthen causal inferences [32].

### H. SUMMARY

In conclusion, this study employed a structured, quantitative approach utilizing a quasi-experimental design to evaluate the influence of an Android-based pregnancy education and care application among pregnant women in Surabaya. The methods detailed above ensure that the study can be reliably replicated and provide robust data on the efficacy of digital health interventions in maternal health promotion.

## III. RESULT

Based on the TABLE 1, it can be seen that most pregnant women are 20-35 years old (90.2%). The highest number of educations taken by pregnant women is secondary school (78.4%) and many pregnant women do not employ (72.5%). It can be seen the most pregnancies are in the third trimester (45.1) and the most are in primipara parity (54.9%). According to TABLE 2, for the category of respondent's level of knowledge, there is a change in each level of knowledge. In good knowledge there was an increase of 13.7%.

TABLE 1
Characteristics of pregnant women

| Characteristics | Frequency (f) | Percentage (%) |
|---|---|---|
| **Age (years)** | | |
| **<20** | 1 | 2.0 |
| **20-35** | 46 | 90.2 |
| **>35** | 4 | 7.8 |
| **Education** | | |
| **High** | 4 | 7.8 |
| **Secondary** | 40 | 78.4 |
| **Basic** | 7 | 13.7 |
| **Did not school** | 0 | 0 |
| **Employment status** | | |
| **Employed** | 14 | 27.5 |
| **Not employed** | 37 | 72.5 |
| **Parity** | | |
| **Primipara** | 28 | 54.9 |
| **Multipara** | 23 | 45.1 |
| **Grandemultipara** | 0 | 0 |
| **Gestational age** | | |
| **Trimester I** | 9 | 17.6 |
| **Trimester II** | 19 | 37.3 |
| **Trimester III** | 23 | 45.1 |

TABLE 2
Frequency Distribution of Respondents Knowledge Level

| Knowledge Level | Before | | After | |
|---|---|---|---|---|
| | Freq. (f) | Perc. (%) | Freq. (f) | Perc.(%) |
| **Less** | 4 | 7.8 | 0 | 0 |
| **Enough** | 5 | 9.8 | 2 | 3.9 |
| **Good** | 42 | 82.4 | 49 | 96.1 |

From the results oof the Wilcoxon Signed Ranks Test, the p value = 0.005 (there was an effect of using Android-based pregnancy education and care applications to improve knowledge in pregnant women) (TABLE 3). According to TABLE 4, for the category of respondent's level of attitude, there is a change in each level of attitude. In good attitude there was an increase of 19.6%. From the results oof the Wilcoxon Signed Ranks Test, the p value = 0.008 (there was an effect of using Android-based pregnancy education and care applications to improve attitudes in pregnant women). According to table 6, for the category of respondent's level of practice, there is a change in each level of practice. In good practice there was an increase of 15.7% (TABLE 5).

TABLE 3
Effect of Respondents Knowledge (n=51)

| | Value Min-Max | Median | Mean | Std. Deviation | p |
|---|---|---|---|---|---|
| **Before** | 2-10 | 9 | 8.59 | 1.780 | 0.005 |
| **After** | 6-10 | 10 | 9.61 | 0.874 | |

*) Wilcoxon Signed Ranks Test

TABLE 4
Frequency Distribution of Respondents Attitude Level

| Attitude Level | Before | | After | |
|---|---|---|---|---|
| | Frequency (f) | Percentage (%) | Frequency (f) | Percentage (%) |
| **Less** | 1 | 2.0 | 0 | 0 |
| **Enough** | 11 | 21.6 | 2 | 3.9 |
| **Good** | 39 | 76.5 | 49 | 96.1 |

TABLE 5
Effect of Respondents Attitude (n=51)

| | Value Min-Max | Median | Mean | Std. Deviation | p |
|---|---|---|---|---|---|
| **Before** | 23-35 | 26 | 26.78 | 2.671 | 0.008 |
| **After** | 23-32 | 29 | 28.39 | 2.376 | |

*) Wilcoxon Signed Ranks Test

TABLE 6
Frequency Distribution of Respondents Practice Level

| Practice Level | Before | | After | |
|---|---|---|---|---|
| | Frequency (f) | Percentage (%) | Frequency (f) | Percentage (%) |
| **Less** | 2 | 3.9 | 0 | 0 |
| **Enough** | 8 | 15.7 | 2 | 3.9 |
| **Good** | 41 | 80.4 | 49 | 96.1 |

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TABLE 7
Effect of Respondents Practice (n=51)

| | Value Minimum-Maximum | Median | Mean | Std. Deviation | p |
|---|---|---|---|---|---|
| Before | 3-7 | 7 | 6.39 | 0.961 | 0.019 |
| After | 5-7 | 7 | 6.82 | 0.478 | |

*) Wilcoxon Signed Ranks Test

From the results oof the Wilcoxon Signed Ranks Test, the p value = 0.019 (there was an effect of using Android-based pregnancy education and care applications to improve practice in pregnant women) (TABLE 6 and TABLE 7).

## IV. DISCUSSION

The present study demonstrated a significant positive impact of Android-based pregnancy education and care applications on maternal health behaviors among pregnant women. Specifically, there was a marked increase in participants' knowledge, attitudes, and actions related to pregnancy management post-intervention. The statistical significance of these improvements, evidenced by p-values less than 0.05 in the Wilcoxon test, underscores the efficacy of digital health interventions in empowering pregnant women to adopt healthier behaviors. This enhancement in maternal health behavior aligns with the Health Belief Model, which posits that increasing perceived benefits and self-efficacy through accessible information can precipitate behavioral change [34]. The use of mobile technology, especially Android applications, offers a platform for continuous, tailored health education, overcoming traditional barriers such as limited health facility access, especially during pandemics like COVID-19 [35]. Furthermore, the data indicate that most pregnant women in the sample were within the age group of 20–35 years (90.2%), and predominantly held secondary education levels (78.4%). This demographic profile suggests that digital literacy among this population segment is adequate, facilitating the effective utilization of smartphone-based applications. The observed improvements in knowledge and subsequent behavior change likely resulted from the integration of interactive and user-friendly features embedded within these applications, such as alerts, educational materials, and self-monitoring tools.

These findings resonate with emerging studies published within the last five years emphasizing the role of mobile health (mHealth) tools in maternal health promotion. For instance, a recent systematic review by Ahmad et al. [36] highlights that mHealth interventions significantly improve health knowledge, adherence to antenatal care, and health outcomes in pregnant women across diverse settings. Similarly, Kumar et al. [37], in their cross-sectional study, reported that pregnant women utilizing smartphone applications demonstrated higher compliance with prenatal appointments and nutritional advice. Contrasting with some prior studies, such as that by Lee et al. [38], which identified barriers related to technological literacy and cultural acceptance, our study's positive outcomes suggest that in populations with adequate digital familiarity, smartphone applications can serve as highly effective tools. However, variations in the degree of impact across different contexts underscore the importance of tailoring digital interventions to local cultural, linguistic, and socioeconomic conditions. Moreover, the observed increase in attitudes and actions following application use affirms findings by Zhang et al. [39], who demonstrated that mobile applications enhancing knowledge also positively influence behavioral intentions and actual practices. Conversely, some studies, such as that by Smith et al. [40], have pointed out that mere access to information does not guarantee behavioral change without ongoing engagement and reinforcement a factor to be considered in future app development.

While the results are promising, several limitations must be acknowledged. First, the study's quasi-experimental design without a control group limits the ability to definitively attribute behavioral improvements solely to the application intervention, as external factors may have influenced the outcomes. Additionally, the relatively small sample size (51 participants), although sufficient for detecting significant changes, restricts the generalizability of the findings to broader populations. Moreover, the reliance on self-reported questionnaires introduces potential bias, including social desirability bias, which could lead to overestimations of behavioral improvements. Technical limitations within the application, such as the requirement for internet connectivity via barcode scanning that was time-sensitive, posed practical challenges, potentially affecting participant engagement and data accuracy. Despite these constraints, the study's findings imply that integrating Android-based applications into routine prenatal care can substantially enhance pregnant women's health literacy, attitudes, and behaviors. Health practitioners and policymakers should consider adopting such digital tools, especially in remote or resource-limited areas, to augment traditional health education initiatives. The scalability and cost-effectiveness of mobile applications make them a promising avenue for addressing maternal health disparities, particularly during pandemics or other crises disrupting conventional healthcare delivery. In conclusion, leveraging technology for maternal health promotion offers a viable strategy to improve pregnancy outcomes. However, future research should endeavor to employ randomized controlled trial designs, larger sample sizes, and longer follow-up periods to validate and expand upon these findings, ultimately contributing to evidence-based digital health policies.

## V. CONCLUSION

The primary objective of this research was to assess the impact of Android-based pregnancy education and care applications on enhancing maternal health behaviors among pregnant women. The findings demonstrate that the intervention significantly influenced various aspects of maternal behavior, including knowledge, attitudes, and actions related to pregnancy care. Specifically, the study revealed notable improvements post-intervention, with statistical analysis indicating a significant increase in knowledge levels by 13.7%, and significant changes in attitudes and behaviors with p-values of 0.008 and 0.019 respectively, all falling below the alpha threshold of 0.05. These results affirm that the utilization

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of digital health interventions, particularly Android-based applications, can effectively promote positive health practices among pregnant women, thereby potentially reducing maternal and neonatal risks. The observed improvements underscore the importance of integrating technology into prenatal education programs, especially in contexts where traditional methods may face limitations such as during pandemic conditions or in resource-constrained settings. Despite these promising outcomes, it is essential to acknowledge certain study limitations, including reliance on barcode-based applications that require internet access and are time-limited, which may affect the ease of implementation and scalability. Future research should explore larger, more diverse populations to verify the generalizability of these findings and evaluate the long-term sustainability of behavior changes prompted by digital interventions. Additionally, investigations into alternative delivery mechanisms, such as offline applications or other technological innovations, could enhance accessibility and user engagement. Expanding the scope to include evaluations of neonatal and maternal health outcomes over an extended follow-up period would also provide more comprehensive evidence on the overall efficacy of Android-based applications in maternal healthcare. Overall, this study contributes valuable insights into the role of mobile health technology in maternal health promotion and highlights the potential for such digital tools to serve as effective adjuncts to conventional prenatal education strategies, supporting healthier behaviors and improved pregnancy outcomes.

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## DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

## AUTHOR CONTRIBUTION

Indah Sari Setyaningrum conceived the study, designed the research, and led the data collection and analysis. Tatarini Ika Pipitcahyani contributed to the literature review and manuscript drafting. Evi Pratami assisted with data analysis and interpretation. Ani Media Harumi provided critical revisions and guidance throughout the research process. Zarinah Binti Abdul Aziz supported the theoretical framework and contributed to manuscript editing. All authors reviewed and approved the final version of the manuscript.

## DECLARATIONS

### *ETHICAL APPROVAL*

The study protocol was evaluated and approved by the Institutional Ethics Committee of the health center, ensuring compliance with ethical standards for research involving human participants. Prior to their involvement, all participants provided written informed consent, with guarantees of confidentiality and the freedom to withdraw from the study at any point without facing any consequences.

### *CONSENT FOR PUBLICATION PARTICIPANTS.*

Consent for publication was given by all participants

### *COMPETING INTERESTS*

The authors declare no competing interests.

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