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mHealth Interventions Improve Knowledge and Health Behavior and Reduce Postpartum Complications

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Abstract

Early discharge of postpartum mothers reduces opportunities for comprehensive education, increasing the risk of complications due to inadequate self-care. This study evaluated the effectiveness of an m-Health application in improving knowledge and self-care behaviors among postpartum mothers and examined their roles in reducing postpartum complications. A quasi-experimental non-equivalent control group design was used, involving 120 mothers (60 intervention, 60 control) recruited from four community health centers in Semarang City in 2025 through purposive sampling. The intervention was the m-Health application, with knowledge and self-care behavior as mediators and postpartum complications as the outcome. Data were analyzed using ANCOVA. Results showed that the m-Health intervention significantly improved both knowledge (p=0.01) and self-care behavior (p=0.01). It also significantly reduced postpartum complications across all observation periods. Self-care behavior acted as a significant protective factor during days 3–7 (p=0.04), days 8–28 (p=0.00), and days 29–42 (p=0.00). In contrast, knowledge alone did not significantly reduce complication in any period. These findings indicate that m-Health interventions are effective in enhancing postpartum self-care and reducing complications, primarily by promoting adaptive health behaviors rather than improving knowledge alone.

Introduction

The Maternal Mortality Rate (MMR) is one of the primary indicators of public health status. Globally, World Health Organization (WHO) data show that in 2018, the MMR reached 8.30 per 100,000 live births due to pregnancy and childbirth complications, with the largest increase reaching 78.23 per 100,000 live births—a figure 59.46% higher than the estimated ratio of 49.06% (de Carvalho-Sauer *et al.*, 2021). In Indonesia, this situation was further worsened by the COVID-19 pandemic. The Ministry of Health of the Republic of Indonesia (2021) recorded that maternal deaths increased from 4,627 cases in 2020 to 7,389 cases in 2021 (Ministry of Health of the Republic of Indonesia, 2021). Fatmaningrum et al. (2022) also reported a pandemic-driven increase of 565 maternal deaths in 2022, and if not immediately addressed, this figure is projected to continue rising by 45 cases annually and in 2023, increase by 125 cases (Fatmaningrum et al., 2022; Joseph et al., 2024).

At the regional level, the Central Java Health Profile 2022 published by the Central Bureau of Statistics (2023) recorded that maternal death during the postpartum period reached 50.7 per 100,000 live births out of a total of 199 maternal deaths in 2021, meaning that nearly 27% of all maternal deaths occurred in the postpartum period. Semarang City ranked 10th for the highest MMR in Central Java and was the city with the highest MMR among all cities in Central Java, with an MMR of 95.3 per 100,000 live births in 2021 and 67.25 in 2022. Data from the Semarang City Health

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Office (2023) indicate that the leading causes of postpartum maternal deaths during 2022–2023 were hemorrhage (37–40%), pre-eclampsia (21–26%), and sepsis (6–13%), confirming that the postpartum period is the most vulnerable phase for post-delivery mothers.

The postpartum period is a critical transitional phase requiring intensive monitoring and care. Complications that may arise during this period include puerperal infection, mastitis, hematoma, delayed postpartum hemorrhage, sub-involution of the uterus, thrombophlebitis, uterine inversion, and psychological disorders (Safitri *et al.*, 2022). Current early discharge policies for postpartum mothers—aimed at reducing costs and strengthening family roles—in fact shorten the opportunity for healthcare workers to provide comprehensive education to mothers. This situation may lead to inadequate readiness among mothers to care for themselves and their newborns after returning home (Lindblad *et al.*, 2021). Axelsson *et al*. (2018) noted that clinical postpartum infections, including mastitis (4.7%), urinary tract infections (3.0%), and endometritis (2.0%), are entirely dependent on the quality of self-care practiced by postpartum mothers independently (Axelsson *et al.*, 2018).

Maternal knowledge about postpartum care plays a central role in preventing complications. Based on Yudianti *et al*. (2017), only 31.3% of mothers had adequate knowledge about postpartum care based on the Maternal and Child Health handbook, while the majority remained in the moderate or poor knowledge categories (Yudianti *et al.*, 2017). Research by Atik & Wandal (2020) further confirmed that there is a relationship between the frequency of postpartum visits and improvements in maternal knowledge—the more frequent the visits, the better the knowledge (Atik & Wandal, 2020). Khoirunnisa & Elfira (2023) added that maternal knowledge can be acquired through various media, both print and electronic (Khoirunnisa & Elfira, 2022). Primiparous mothers generally require more information than multiparous mothers due to significant differences in experience with childbirth and the postpartum process (Javanmardi *et al.*, 2018). Primiparous mothers tend to have greater informational needs compared to multiparous mothers, as their limited experience with childbirth and the postpartum period increases their reliance on guidance and education from healthcare providers (Chan & Chen, 2019; Nilsson *et al*., 2021)

Health behavior among postpartum mothers, particularly postpartum visit behavior and home self-care practices, is an important determinant in preventing complications. Research by Windarti & Dewi (2018) found that many postpartum mothers are still reluctant to clean their genitalia, especially perineal suture wounds, and perform postpartum exercises inconsistently due to a lack of commitment (Windarti & Dewi, 2018). Meanwhile, postpartum visit coverage in Semarang City in 2022 reached only 97.99%, falling short of the 100% target and declining compared to 99.94% in 2021 (Semarang City Health Office, 2023). Community observations show that mothers often complete only one or two visits during the postpartum period because they feel their condition has already recovered, despite the fact that postpartum care standards encompass physical examinations, postpartum exercises, vitamin A supplementation, problem management, and family planning counseling (Ministry of Health RI, 2020).

Previous research has demonstrated the effectiveness of educational interventions in improving postpartum maternal knowledge and behavior, such as the use of the digital application "Puerperal Healthy," which proved more effective than conventional Maternal and Child Health handbooks in improving postpartum maternal knowledge (Herlina *et al.*, 2020), and community-based interventions that were able to increase postpartum care visits (Pallangyo *et al.*, 2017). However, a research gap remains regarding the direct relationship between levels of postpartum maternal knowledge and self-care behavior and the incidence of postpartum complications, particularly in urban settings such as Semarang City. Furthermore, no study has explicitly examined the role of the m-Health application as an intervention to improve postpartum self-care knowledge and behavior, while simultaneously investigating both variables as mediators in the relationship between digital intervention and the reduction of postpartum

complications. This study addresses that gap by analyzing the effectiveness of the m-Health application in improving knowledge and self-care behavior, and examining the role of both as mediators in postpartum complication incidence, as a basis for developing a more effective and standardized postpartum care intervention model.

This study aimed to analyze the effectiveness of the m-Health application intervention in improving knowledge and self-care behavior among postpartum mothers. Additionally, it examined the role of knowledge and behavior as mediators between the application intervention and the reduction of postpartum complications. The findings are expected to provide a scientific basis for healthcare workers in designing a comprehensive digital technology-based postpartum care intervention model, including the development of e-health media based on Orem's Self-Care Theory, to improve knowledge, self-care compliance, and reduce complication rates among postpartum mothers in Semarang City.

Methods

This study employed a quantitative approach with a quasi-experimental, non-equivalent control group design. The study sample consisted of 120 respondents divided into 60 in the intervention group and 60 in the control group, distributed evenly across four community health centers (15 respondents per group per puskesmas). Purposive sampling was used. Inclusion criteria included: postpartum mothers on days 2 to 3 post-delivery, aged 18–40 years, owning an Android/iOS smartphone, residing in an area with a minimum 3G internet connection, and willing to participate for four weeks. Exclusion criteria included: severe postpartum complications (massive hemorrhage, sepsis, pre-eclampsia), neonates admitted to NICU for more than seven days, history of severe mental disorders, and illiteracy that hinders application use.

The independent variable in this study was the m-Health application intervention. The application contains postpartum care information, including educational materials on maternal self-care (Dol *et al.*, 2019). There is also a questionnaire feature to assess the level of knowledge, behavior, and complications experienced. It features user-friendly navigation, interactive education modules, and a reminder system to support adherence. The recommended duration of use is daily during the postpartum period from day 3 to day 42, with frequent access encouraged to reinforce learning. The application also includes a feedback mechanism to monitor user progress, and adherence is supervised by healthcare providers or assigned professionals via the consultation feature. Mediating variables were postpartum care knowledge and self-care behavior. The dependent variable was postpartum complications. A mediation analysis model was used to examine the role of knowledge and behavior as pathways mediating the effect of the application intervention on the reduction of postpartum complications. Data collection instruments consisted of four validated and reliable questionnaires. The postpartum care knowledge questionnaire was

TABLE 1. Summary of Research Variables and Instruments

Variables	Instruments	Measurement Outcome	Scale
m-Health Intervention	m-Health application education module	Intervention vs. control group	Nominal
Postpartum knowledge	KAP WHO (2010), 13 items	0–13	Interval
Postpartum behavior	21-item questionnaire, Likert 1–5	21–105	Interval
Postpartum complications	WOICE-WHO, 28 items (3 periods)	0–1 per item	Interval

Source : Primary research data, 2025

adapted from the WHO Knowledge, Attitude, Practice (KAP) instrument (2010) with 13 dichotomous scale items (0–1). The postpartum care behavior questionnaire consisted of 21 Likert-scale statements (1–5). The postpartum complications questionnaire was developed from the WOICE-WHO instrument, divided into three periods: complications on days 3–7 (13 items), days 8–27 (10 items), and days 28–42 (5 items).

Quantitative data were analyzed in stages by one-way ANOVA to test the effect of the intervention on postpartum self-care knowledge and behavior, followed by ANCOVA, which used postpartum complications as the dependent variable, the intervention as the independent variable, and postpartum self-care knowledge and behavior as covariates.

Results and Discussion

A total of 120 postpartum mothers participated in this study, with a balanced distribution between the intervention group (n=60) and the control group (n=60). Descriptive data from the study are presented in Table 2.

Analysis results using comparative descriptive, the intervention group had a higher mean knowledge score than the control group (85.51 vs. 78.31). Additionally, the standard deviation in the intervention group was smaller (10.51), indicating that knowledge scores in this group were more homogeneous (more uniform). In contrast, the control group showed greater score variation (SD 17.63). Meaning some respondents had very low and very high knowledge scores. The intervention appeared effective in improving postpartum maternal knowledge, as well as making knowledge outcomes more equitable. The intervention group demonstrated better self-care behavior (84.25 vs. 80.23). Although the difference was not very large (approximately 4 points), the standard deviation in the intervention group was smaller, indicating greater behavioral consistency. This suggests that the intervention not only improved behavior on average but also reduced inter-individual disparities.

Complications within day 3–7 were considerably lower in the intervention group (27.62 vs. 40.75). This is a substantial and clinically meaningful difference. The standard

TABLE 2. Result of Descriptive Analysis Knowledge, Self-Care Behavior, Postpartum Complications

	Intervention Group		Control Group	
	Mean	**Std. Dev**	**Mean**	**Std. Dev**
Knowledge	85.51	10.51	78.31	17.63
Self-Care Behavior	84.25	8.09	80.23	9.68
Postpartum Complications (Days 3–7)	27.62	12.30	40.75	8.69
Postpartum Complications (Days 8–28)	33.50	11.62	43.77	11.86
Postpartum Complications (Days 29–42)	29.33	11.33	44.92	15.34

Source : Primary research data, 2025

TABLE 2. Results of Analysis of the Effect of Intervention on Knowledge and Behavior

Independent Variable	**Knowledge**		**Self-Care Behavior**	
	t	**Sig.**	**t**	**Sig.**
Intervention	2.86	0.01	2.58	0.01

Source : Primary research data, 2025

deviation in the intervention group was higher (12.3 vs. 8.69), which may indicate that although the mean was lower, some respondents in the intervention group still experienced relatively high complications. Overall, however, the intervention was highly effective in reducing complications in the early postpartum period. The control group still had higher complication scores in days 8–28 (43.77 vs. 33.5). The standard deviations of both groups were nearly equal, indicating comparable variation. This means the protective effect of the intervention persisted through day 28, although the difference narrowed slightly compared to the days 3–7 period. In the late postpartum period (days 29–42), the difference became most pronounced (29.33 vs. 44.92). The control group even showed an increase in complications compared to the previous period (from 43.77 to 44.92), while the intervention group showed a stable or declining trend from days 8–28 (33.5 to 29.33). The larger standard deviation of the control group (15.34) indicates that, without intervention, complication risk varies considerably and tends to be high in some mothers.

Statistical test results show that the m-Health application intervention had a significant effect on both dependent variables. For the knowledge variable, t=2.86 with a significance of 0.01 ($p<0.05$) was obtained, indicating that the intervention produced a meaningful improvement in knowledge in the intervention group compared to the control group. Similarly, for the self-care behavior variable, t=2.58 with a significance of 0.01 ($p<0.05$) was obtained, confirming that the intervention was also significant in changing postpartum maternal behavior. Although the t-value for behavior (2.58) was slightly lower than for knowledge (2.86), both had the same significance level, indicating that the application was comprehensively effective in both improving knowledge and shaping self-care behavior. This finding also bridges the knowledge-behavior gap frequently observed in health education research and supports the frameworks of Orem's Self-Care Theory and the Theory of Planned Behavior—that a supportive-educative approach based on digital technology can effectively transform information into real action. Accordingly, this application is well-suited for recommendation as a standard supporting medium in postpartum care at healthcare facilities. ANCOVA analysis was conducted to examine the effect of the m-Health application intervention on postpartum complications, with knowledge and behavior as covariates. Results are presented in Table 3.

ANCOVA results show that the overall model was significant for all postpartum complication periods (Corrected Model: $p=0.00$). The knowledge variable did not have a significant effect on postpartum complications in any period: days 3–7 ($p=0.38$), days 8–28 ($p=0.86$), or days 29–42 ($p=0.27$). These findings are consistent with Friani *et al.* (2022), who emphasized that knowledge unaccompanied by practice is insufficient to reduce complication risk. Theoretically, this result can be explained through the framework of the Theory of Planned Behavior (Ajzen), which posits that knowledge is a predisposing factor, but intentions and actual behavior are strongly

TABLE 3. Results of ANCOVA Analysis: Effect of Intervention, Knowledge, and Behavior on Postpartum Complications (with Knowledge and Behavior as Covariates)

		Comp. Days 3–7		**Comp. Days 8–28**		**Comp. Days 29–42**	
Dependent Variable:	df	F	Sig.	F	Sig.	F	Sig.
Corrected Model	3	16.87	0.00	11.32	0.00	17.42	0.00
Intercept	1	23.83	0.00	30.04	0.00	29.12	0.00
Knowledge	1	0.76	0.38	0.03	0.86	1.24	0.27
Behavior	1	4.36	0.04	9.73	0.00	9.44	0.00
Intervention	1	31.33	0.00	14.27	0.00	25.75	0.00

Source : Primary research data, 2025

influenced by perceived behavioral control and subjective norms. In other words, knowing how to care for oneself does not guarantee that a mother will do so correctly without practical skills and self-efficacy. Orem's Supportive-Educative Self-Care Theory further reinforces this, as the role of educator and supporter is essential in transforming knowledge into real action through ongoing guidance and teaching.

In contrast, the self-care behavior variable showed a consistently significant effect across all periods: days 3–7 (p=0.04), days 8–28 (p=0.00), and days 29–42 (p=0.00). A study by Rehman *et al.* (2025) on nurse-led educational interventions demonstrated significant improvements in postpartum maternal knowledge and self-care practice, resulting in a reduction in postpartum complications (Rehman *et al.*, 2025). Similarly, Ghiasvand *et al.* (2017), using a Teach-Back-based self-care program, successfully improved the quality of life of postpartum mothers and reduced complications through enhanced self-care behaviour (Ghiasvand *et al.*, 2017). In the Indonesian context, research by Rika *et al.* (2023) using postpartum education booklets demonstrated that educational interventions consistently improved knowledge, attitudes, and self-care behavior among postpartum mothers, thereby reducing complication risk (Rika *et al.*, 2023). Other researchers also confirmed that good independent postpartum care practices directly correlate with reductions in complications such as infection and hemorrhage (Friani *et al.*, 2022; Teferi *et al.*, 2024; Wulandari *et al.*, 2026).

These findings are highly relevant to the present study, which delivered the intervention through an application. The effectiveness of the smartphone application "Nutriatlet" in increasing energy intake among martial arts athletes supports the notion that smartphone-based applications effectively change health behaviors, indicating that digital platforms can strengthen adherence to self-care practices (Budiono *et al.*, 2018). In line with this, Mental health education for pregnant women during the COVID-19 pandemic in Surakarta, Indonesia, and moving education and individual education as communities' health education models in health emergency conditions emphasize that structured and adaptive education improves knowledge and behavior, which are essential components of postpartum self-care (Kusumawati *et al.*, 2023; Handayani *et al.*, 2023). Furthermore, is digital healthcare a trend or a necessity? highlights that digital health interventions enhance accessibility, continuity of care, and patient independence, which are directly aligned with the objectives of this application-based intervention (Dewi & Mahyuni, 2024).

However, some studies indicate that increased knowledge does not always lead to behavioral change. Factors such as cultural beliefs, family support, and access to healthcare services may limit the translation of knowledge into practice (Teferi *et al.*, 2024; Alemayehu *et al.*, 2021; Wulandari *et al.*, 2026). This suggests that behavior is multidimensional and influenced by cognitive factors as well as social and environmental determinants. Overall, the ANCOVA results convincingly demonstrate the effectiveness of the intervention as a preventive strategy against postpartum complications, with the most dominant contribution coming from the intervention itself, and supported by self-care behavior as a critical mediator. Furthermore, the intervention factor (intervention group vs. control group) showed a highly significant effect across all periods after controlling for knowledge and behavior. In the days 3–7 period, F=31.33 (p=0.00); days 8–28 period, F=14.27 (p=0.00); and days 29–42 period, F=25.75 (p=0.00). These figures indicate that the intervention group had considerably fewer complications than to the control group, with the strongest intervention effect observed in the early postpartum period (days 3–7) and again increasing in the late period (days 29–42). In other words, the contrast between intervention and control groups serves as a strong indicator of the application's success. These results align with Leavell & Clark's Levels of Prevention theory, particularly at the Early Diagnosis and Prompt Treatment stage (Nurfaika, 2021).

Friani *et al.* (2022) similarly reported that the intervention group receiving comprehensive postpartum education through face-to-face counseling, leaflets, and self-care demonstrations experienced significant

improvements in postpartum knowledge and self-care practice compared to the control group ($p<0.001$). Notably, Krisnawati *et al.* (2022) at the Ketahun Community Health Center, also using ANCOVA analysis, demonstrated that the intervention variable (use of postpartum abdominal binders) simultaneously influenced the uterine involution process of postpartum mothers (Krisnawati *et al.*, 2022). These results suggest that the intervention was effective not only through improvements in knowledge and behavior, but also through direct and independent effects, possibly via psychological support, early detection by healthcare workers, assured access to services, or other specific components of the intervention. Overall, the ANCOVA results reinforce the evidence that structured intervention programs are strongly recommended as part of standard postpartum care. Health education alone is insufficient; an approach that emphasizes the formation of good self-care behavior from the early postpartum period through 42 days post-delivery is required, using interactive and participatory methods such as demonstrations, mentoring, and home visits. Healthcare workers, particularly midwives, are encouraged to more actively deliver regular health education—both through individual and group counseling—so that mothers can correctly implement self-care and prevent complications. Orem's Supportive-Educative approach can serve as an appropriate theoretical framework for enhancing postpartum maternal independence in self-care (Younas, 2017).

The theoretical implications of this study's findings support Orem's Self-Care Theory and the Theory of Planned Behavior—that knowledge must be transformed into real action through a supportive-educative approach. The practical implications are that healthcare workers should provide health education accompanied by demonstrations and self-care practice mentoring, optimize at least four postpartum visits, and implement structured interventions such as postpartum mother classes or home visits. Health service management should replicate this program within standard postpartum care protocols, while future researchers are advised to conduct randomized controlled trials (RCTs) with longer follow-up periods. Health policies should strengthen the healthcare worker education curriculum regarding behavioral change methods, as structured and continuous interventions have been shown to effectively and meaningfully reduce postpartum complications.

Conclusion

The study results show that the intervention group had significantly higher postpartum self-care knowledge and behavior compared to the control group ($p<0.05$), as well as considerably lower postpartum complication rates across all periods (days 3–7, 8–28, and 29–42). ANCOVA analysis confirmed that the intervention continued to have a significant effect on reducing complications after controlling for knowledge and behavior ($p=0.00$), with self-care behavior serving as a strong protective factor, while knowledge alone was insufficient. Healthcare providers, particularly midwives, are encouraged to integrate m-Health applications into routine postpartum care to strengthen education, monitoring, and patient engagement. Health institutions should adopt structured digital-based intervention programs as part of standard postpartum services. Future research is recommended to use randomized controlled trial (RCT) designs with larger sample sizes and longer follow-up periods to further validate the effectiveness of m-Health interventions.

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