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Effectiveness of a family-centered empowerment-based digital pocketbook on self-efficacy and iron supplement adherence among pregnant women: A quasi-experimental study

Efektivitas buku saku digital berbasis pemberdayaan berpusat pada keluarga terhadap efikasi diri dan kepatuhan suplementasi zat besi pada ibu hamil: Studi kuasi-eksperimental

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Abstract

Pregnancy-related anemia remains a major public health problem in Indonesia, largely attributable to low iron supplementation adherence among pregnant women. Evidence regarding digital interventions based on the family centered empowerment model (FCEM) remains limited. This study aimed to evaluate the effectiveness of an FCEM-based digital E-Pocket Book in improving self-efficacy and adherence to iron tablet consumption among pregnant women. A quasi-experimental pretest–posttest control group study was conducted at the Sentosa Baru Community Health Center in Medan, Indonesia, from July to August 2025. A total of 50 pregnant women (gestational age, 14–36 weeks) were allocated to an intervention group (n = 25) and a control group (n = 25). The intervention group received the FCEM-based E-Pocket Book for four weeks, while the control group received standard antenatal education. Data were analyzed using the Wilcoxon signed-rank and Mann–Whitney U tests. The intervention group demonstrated significantly greater improvements in self-efficacy (p = 0.027; d = 0.78) and adherence to iron supplementation (p = 0.001; d = 0.91) than the control group. In conclusion, the family-centered empowerment–based digital pocketbook is effective in improving self-efficacy and adherence to iron supplementation among pregnant women.

Keywords: Digital health education, FCEM, iron supplementation, pregnancy, self-efficacy

Abstrak

Anemia terkait kehamilan masih menjadi masalah kesehatan masyarakat utama di Indonesia, sebagian besar disebabkan oleh rendahnya kepatuhan terhadap suplementasi zat besi di kalangan ibu hamil. Bukti tentang intervensi digital berdasarkan Model Pemberdayaan Berpusat pada Keluarga (FCEM) masih terbatas. Studi ini mengevaluasi efektivitas E-Pocket Book digital berbasis FCEM dalam meningkatkan efikasi diri dan kepatuhan terhadap konsumsi tablet zat besi. Studi kelompok kontrol pra-uji-pasca-uji kuasi-eksperimental dilakukan di Puskesmas Sentosa Baru, Medan, Indonesia, dari Juli hingga Agustus 2025. Lima puluh ibu hamil (usia kehamilan 14–36 minggu) dibagi menjadi kelompok intervensi (n = 25) dan kelompok kontrol (n = 25). Kelompok intervensi menerima E-Pocket Book berbasis FCEM selama empat minggu, sedangkan kelompok kontrol menerima pendidikan antenatal standar. Data dianalisis menggunakan uji Wilcoxon Signed Rank dan Mann–Whitney U. Kelompok intervensi menunjukkan peningkatan yang

signifikan dalam efikasi diri (p = 0.027; d = 0.78) dan kepatuhan suplementasi zat besi (p = 0.001; d = 0.91) dibandingkan dengan kelompok kontrol. Kesimpulannya, E-Pocket Book berbasis FCEM secara efektif meningkatkan efikasi diri dan kepatuhan terhadap suplementasi zat besi di kalangan wanita hamil.

Kata Kunci: Efikasi diri, FCEM, kehamilan, pendidikan kesehatan digital, suplementasi zat besi

Introduction

One of the central aims of the Sustainable Development Goals (SDGs), particularly Goal 3, which focuses on promoting health and well-being, is to reduce the global maternal mortality ratio to fewer than 70 deaths per 100,000 live births (Gamage et al., 2022). Among the conditions that substantially contribute to adverse maternal outcomes is anemia, which affects nearly 40% of pregnant women worldwide, particularly in low- and middle-income countries (Obeagu et al., 2025). Beyond its clinical consequences, anemia during pregnancy is closely associated with behavioral factors, most notably inadequate adherence to iron supplementation programs, which undermines efforts to prevent iron deficiency and its related complications. Consequently, improving adherence to iron supplementation through effective behavioral and educational strategies remains a critical component of maternal health intervention (Ari et al., 2024).

Data from national surveys and regional studies indicate that anemia affects between 36.2% and 48.9% of pregnant women in the country. In several regions, including Central Java, East Lombok, and Serang City, the prevalence exceeds 50%, a level classified by the World Health Organization as a severe public health problem (Ameline et al., 2025; Nurfajriah et al., 2024). Despite the long-standing national Iron Supplement Tablet program, these persistently high rates suggest that biomedical provision alone is insufficient. Inadequate adherence to iron tablet consumption, shaped by behavioral, psychosocial, and contextual factors, remains a major barrier to achieving the program's intended impact (Yani et al., 2023).

Improved adherence to iron supplement tablet intake has been consistently associated with better maternal iron status and reduced risk of anemia and pregnancy-related complications. To address behavioral barriers, digital health education tools, such as mobile applications, interactive educational content, and reminder systems, have been increasingly implemented and shown to improve knowledge and adherence among pregnant women (Hairiyah et al., 2023). However, many existing digital interventions primarily emphasize information delivery and individual behavior change, with limited integration of family involvement and empowerment. Incorporating the Family-Centered Empowerment Model (FCEM) into digital health education offers a more comprehensive approach by strengthening self-efficacy, enhancing family support, and promoting active participation in health-related behavior (Someia et al., 2020).

The compliance with iron tablet intake among pregnant women in Indonesia remains suboptimal. Several studies have reported that only 21.8% to 25.5% of pregnant women consistently adhere to the recommended iron supplementation regimen, while non-compliance rates reach 59.3% in regions such as Central Aceh, and adherence in Ambon remains as low as 21.8% (Dewi et al., 2024). These low adherence rates are not solely attributable to limited access or availability of supplements but are strongly influenced by psychosocial determinants, including low self-efficacy, insufficient family support, fear of side effects, and lack of motivation to sustain their long-term consumption (Danziger-Isakov et al., 2019). Therefore, addressing these determinants is essential for improving adherence outcomes and reducing the prevalence of anemia.

The Family Centered Empowerment Model (FCEM) emphasizes the active involvement of individuals and their families in recognizing health risks, enhancing self-efficacy, fostering participation, and sustaining health-promoting behavior (Lin et al., 2025). In the Indonesian context, this approach aligns with national health development priorities, including efforts to strengthen human capital and improve maternal health outcomes in the country. Within Indonesia's broader public health policy framework, these priorities are reflected in the *Asta Cita* agenda, a national development strategy that emphasizes health promotion and the development of high-quality resources (Alfaqeeh et al., 2025). Although

this framework is context-specific, its principles align with global maternal health strategies that prioritize empowerment, community engagement, and preventive care (Singh et al., 2024).

Based on these considerations, a clear gap remains in the empirical evidence regarding the effectiveness of digital health education interventions explicitly grounded in the Family-Centered Empowerment Model for improving self-efficacy and adherence to iron supplementation among pregnant women. Therefore, this study aimed to examine the effectiveness of a family-centered empowerment–based digital pocketbook in enhancing self-efficacy and adherence to iron supplementation among pregnant women.

Methods

Study Design

This study employed a quasi-experimental pretest–posttest control group design, which was considered appropriate given the real-world setting of antenatal care services and the ethical constraints that limited the feasibility of random assignment. Randomization was not implemented because participants were recruited based on service schedules and availability during routine antenatal visits, and strict random allocation could have disrupted standard care at the community health center. Therefore, a non-randomized design was selected to maintain ecological validity while still enabling a comparison between the intervention and control groups.

This study was conducted at the Sentosa Baru Community Health Center in Medan, Indonesia. Participant recruitment and baseline data collection will take place from January to March 2025, followed by intervention implementation and post-test assessment from July to August 2025. This interval allowed sufficient time for the preparation of the digital intervention, training of facilitators, and scheduling of intervention sessions without interfering with routine maternal health services. This study adhered to the TREND (Transparent Reporting of Evaluations with Nonrandomized Designs) guidelines to ensure transparent and systematic reporting.

Participants

The study population consisted of pregnant women in their second and third trimesters who were registered in the antenatal care cohort at the Sentosa Baru Community Health Center. A purposive sampling technique was used to ensure that participants met the eligibility criteria essential for the digital intervention, including the ability to read Indonesian, ownership of a smartphone, and willingness to engage with the E-pocket Book over a four-week period. Consecutive sampling was not applied because not all antenatal care attendees met these criteria, particularly regarding digital access and digital literacy.

The inclusion criteria were pregnancy at a gestational age of 14–36 weeks, literacy (ability to read and write), ownership of a smartphone with internet access, and willingness to participate throughout the intervention period. The exclusion criteria included severe medical complications, such as preeclampsia, severe anemia (hemoglobin <8 g/dL), or other conditions that could interfere with participation.

A total of 50 participants were included in the study, with 25 assigned to the intervention group and 25 to the control group. Although a formal power analysis was not conducted, this sample size was considered adequate for an exploratory quasi-experimental study aimed at assessing feasibility and preliminary effectiveness of the intervention. Similar sample sizes have been used in previous intervention studies evaluating behavioral and educational outcomes among pregnant women. A baseline imbalance in anemia status between groups was observed and acknowledged as a limitation affecting internal validity.

Instruments

Data were collected using three primary instruments: the FCEM-based Iron Supplement E-Pocket Book, a self-efficacy questionnaire, and the Morisky Medication Adherence Scale–8 (MMAS-8).

The self-efficacy questionnaire was adapted from Bandura's self-efficacy framework and modified to reflect maternal health and iron supplementation behavior. Content validity was assessed through expert judgment by three specialists in maternal health and health education to ensure the relevance and clarity of the items. Although formal construct validity testing, such as the calculation of a Content Validity Index (CVI), was not performed, internal consistency analysis demonstrated good reliability, with a Cronbach's alpha coefficient of 0.82.

Iron supplementation adherence was assessed using the MMAS-8. Permission to use the instrument for academic research was obtained from its copyright holder. Although the original validation article by Tanaka et al. (2021) was subsequently retracted, the MMAS-8 remains widely used in health behavior research, and its psychometric properties have been supported by subsequent studies. The Indonesian version used in this study demonstrated acceptable reliability, with a Cronbach's alpha of 0.74.

Intervention

Participants in the intervention group received the FCEM-based Iron Supplement E-Pocket Book over a four-week period, delivered in four structured sessions lasting approximately 45 minutes each. The intervention followed standardized operating procedures aligned with the four domains of the Family-Centered Empowerment Model: perceived threat, enhancement of self-efficacy, participation and family involvement, and evaluation.

Data collection and intervention delivery were conducted by trained midwives and enumerators. Owing to the nature of the educational intervention, blinding the data collectors was not feasible. However, outcome assessments were performed using standardized questionnaires to minimize the observer bias. Intervention fidelity was monitored using a checklist covering the session preparation, implementation, and closure.

The missing data were minimal. When missing values occurred, the last observation carried forward (LOCF) method was applied to maintain consistency between the pre- and post-test measurements. This approach was selected to preserve the sample size and minimize bias due to attrition in a short-term behavioral intervention.

Data Collection

The intervention group received the FCEM-based E-Pocket Book through four weekly sessions, each lasting approximately 45 min. The intervention consisted of structured health education grounded in the Family-Centered Empowerment Model and was delivered via the Iron Supplement E-Pocket Book at the Sentosa Baru Community Health Center by the researchers, assisted by a coordinating midwife.

Intervention fidelity was ensured using a standardized checklist documenting three components: (1) preparation, including creating a safe and conducive environment for pregnant women; (2) implementation, involving the delivery of all educational content according to protocol, maintenance of clear communication, and active engagement of participants and their families; and (3) closure, including feedback provision, documentation of participant responses, and recording of barriers or challenges related to iron supplement adherence.

Safety monitoring was conducted throughout the study period, with researchers and midwives documenting any adverse events or participant discomfort and promptly managing issues in accordance with clinical protocols, including referral to medical staff when necessary. Data management procedures included double-entry verification, with missing data addressed using the LOCF method.

Data Analysis

Data analysis was performed using IBM SPSS Statistics (version 26.0). Descriptive statistics were used to summarize the participants' characteristics. The Shapiro–Wilk test indicated that the data were not normally distributed; therefore, non-parametric statistical tests were applied. Within-group changes before and after the intervention were analyzed using the Wilcoxon signed-rank test, and between-group differences were assessed using the Mann–Whitney U test.

Effect sizes (Cohen's *d*) and 95% confidence intervals were calculated to estimate the magnitude of the intervention effect and are reported in the results section. Given the non-normal distribution of the data, homogeneity of variance was not used as a criterion for selecting tests.

Ethical Considerations

Ethical approval for this study was obtained from the Research Ethics Committee of the Universitas Islam Sumatera Utara, Indonesia (approval number: 282/KEPK/FK-UISU/VI/2025). All participants received verbal and written explanations of the study's purpose, benefits, and potential risks before providing written informed consent. The study was conducted in accordance with the principles of confidentiality, anonymity, and the participants' right to withdraw at any time without consequence. All procedures complied with the ethical standards outlined in the Declaration of Helsinki.

Result and Discussion

Baseline Characteristics of Respondents

Table 1 presents the baseline characteristics of the participants in the intervention and control groups. Most respondents in both groups were aged 20–35 years, accounting for 72% of the participants in each group.

Employment status was similarly distributed, with 60% of women in each group reporting employment. The majority of participants had completed senior high school, representing 80% of the intervention group and 76% of the control group participants. Parity distribution was comparable between the groups, with multiparous women comprising 52% of the participants in both groups.

Tabel 1. Distribution of respondents' characteristics

Characteristic	Intervention (n = 25)	Control (n = 25)
	n (%)	n (%)
Age (years)		
<20	2 (8)	3 (12)
20–35	18 (72)	18 (72)
>35	5 (20)	4 (16)
Occupation		
Employed	15 (60)	15 (60)
Unemployed	10 (40)	10 (40)
Educational level		
Junior high school	3 (12)	5 (20)
Senior high school	20 (80)	19 (76)
Higher education	2 (8)	1 (4)
Parity		
Primiparous	12 (48)	12 (48)
Multiparous	13 (52)	13 (52)
Anemia status		
Anemia	15 (60)	7 (28)
Non-anemia	10 (40)	18 (72)

However, a notable difference was observed in the baseline anemia status. In the intervention group, 60% of the participants were anemic, compared with 28% in the control group. Although formal statistical comparisons were not conducted at baseline, this imbalance suggests that the intervention group began the study with a higher burden of anemia, which may have influenced the subsequent outcomes. This baseline difference is acknowledged as a potential confounding factor and represents a limitation that affects internal validity. Participants with anemia may have been more motivated to adhere to iron supplementation, potentially contributing to the observed effects of the intervention. Accordingly, the results should be interpreted with caution, and future studies should incorporate stratified randomization or statistical adjustments to control for baseline anemia status.

Changes in Self-Efficacy

As shown in Table 2, the intervention group demonstrated a statistically significant improvement in self-efficacy following exposure to the FCEM-based E-Pocket Book. In contrast, the control group did not exhibit a significant change in self-efficacy scores between the pre- and post-test assessments.

These findings suggest that the observed improvement in self-efficacy was attributable to the structured, family centered digital intervention rather than routine antenatal education alone. To enhance interpretability, effect size estimates (Cohen's *d*) and 95% confidence intervals were reported to quantify the magnitude of change, as statistical significance alone does not fully capture practical relevance.

Table 2. Changes in self-efficacy scores before and after intervention

Group	Time	Mean	SD	Mean Difference (Δ ± SD)	95% CI (Lower–Upper)	Cohen's d	p-value*
Intervention (n = 25)	Before	1.56	0.65	+1.04 ± 0.73	0.58 – 1.50	0.78	<0.001
	After	2.60	0.83				
Control (n = 25)	Before	1.68	0.80	+0.08 ± 0.79	−0.15 – 0.31	0.1	0.157
	After	1.76	0.78				

*Wilcoxon signed-rank test at 95% CI

Changes in Adherence to Iron Supplementation

The Wilcoxon signed-rank analysis showed that the intervention group experienced a statistically significant increase in iron tablet compliance ($p < 0.001$), with a large effect size (Cohen's $d \approx 0.91$), indicating a strong practical impact of the intervention. In contrast, the control group showed a statistically significant change ($p = 0.014$) but with a small to moderate effect size and a negative direction (Cohen's $d \approx -0.33$), indicating a decrease in compliance during the observation period.

Table 3 indicates that the intervention group experienced a statistically significant improvement in adherence to iron tablet consumption after the intervention. In contrast, the control group exhibited a decline in adherence during the same period. During the manuscript revision, an inconsistency was identified in the initial reporting of the descriptive statistics for self-efficacy and adherence outcomes. These values were subsequently rechecked, and the corrected adherence data are presented to ensure an accurate representation of the results.

Table 3. Changes in adherence to iron supplementation before and after the intervention in the intervention and control groups

Group	Time	Mean	SD	Mean Difference (Δ ± SD)	95% CI (Lower–Upper)	Cohen's d	p-value*
Intervention (n = 25)	Before	1.56	0.65	+0.88 ± 0.68	0.45 – 1.31	0.91	<0.001
	After	2.44	0.71				
Control (n = 25)	Before	1.84	0.69	−0.24 ± 0.72	−0.58 – 0.10	−0.33	0.014
	After	1.6	0.76				

*Wilcoxon signed-rank test at 95% CI

Between-Group Comparisons

The Mann–Whitney U analysis showed significant differences between the intervention and control groups in both self-efficacy ($p = 0.027$; Cohen's $d \approx 0.78$, large effect) and iron supplementation compliance ($p = 0.001$; Cohen's $d \approx 0.91$, large effect), indicating that the Family-Centered Empowerment-based intervention had a strong practical impact on both outcomes.

Table 4. Between-group differences in self-efficacy and adherence to iron supplementation at post-test

Variable	Group	Mean Rank	Estimated Mean Difference (Δ ± SD)	95% CI (Lower–Upper)	Cohen's d	p-value*
Self-efficacy	Intervention	30.04	+0.92 ± 0.75	0.18 – 1.66	0.78	0.027
	Control	20.96				
Adherence to iron supplementation	Intervention	32.28	+1.04 ± 0.78	0.45 – 1.63	0.91	0.001
	Control	18.72				

*Mann–Whitney U test at 95% CI

Table 4 demonstrates the statistically significant differences between the groups in the post-test. The intervention group achieved higher mean ranks for both self-efficacy and adherence to iron supplementation than the control group. These findings reinforce the effectiveness of the FCEM-based digital intervention in improving behavioral outcomes related to iron supplementation among pregnant women.

The findings indicate that pregnant women who received the FCEM-based iron supplement E-Pocket Book experienced greater improvements in self-efficacy and adherence to iron supplementation than those who received standard antenatal education. These improvements may be explained by several, interrelated mechanisms. Family involvement likely provided emotional, informational, and practical support, enhancing the motivation and confidence to sustain regular iron tablet consumption. Additionally, the interactive features of the E-Pocket Book, such as reminders, self-monitoring calendars, quizzes, and reflective exercises, facilitated repeated engagement and behavioral reinforcement, consistent with social cognitive theory and the central role of self-efficacy in maintaining health behaviors.

These results are consistent with those of prior studies demonstrating the effectiveness of digital and family centered educational interventions in improving adherence to iron supplementation. Wulandari et al. (2023) and Al Rahmad & Annisa (2025). reported that e-pocket book-based education improved knowledge, attitudes, and compliance among pregnant women. Similar outcomes have been observed with printed and digital educational materials combined with structured guidance and monitoring (Fayasari et al., 2024; Nahrisah et al., 2020), suggesting that interventions that promote active participation and self-monitoring may be more effective than passive information delivery.

However, evidence from other studies indicates that educational interventions do not always result in sustained behavioral changes. Nadziroh et al. (2020) found that module-based counseling improved knowledge but did not significantly enhance adherence without follow-up. Similarly, McCarthy et al. (2019) reported that digital health tools implemented without interpersonal or family support often fail to achieve long-term behavior change. These contrasting findings highlight the added value of the FCEM approach, which integrates digital education with empowerment and family involvement (Bagur et al., 2025; Mulyana et al., 2023).

From a theoretical perspective, this study extends the application of the Family-Centered Empowerment Model beyond chronic disease management to maternal health. By positioning the family as an active agent rather than a passive context, the FCEM emphasizes the relational nature of health behavior change and integrates individual self-efficacy with broader social dynamics (Alhani et al., 2022). The digital E-Pocket Book demonstrates how empowerment principles can be operationalized through technology, enabling self-regulation, feedback, and structured participation (Heidari et al., 2025; Mulyani et al., 2024; Rhodes et al., 2020).

However, the findings should be interpreted cautiously. Cultural and contextual factors, including digital literacy, family roles, and spousal involvement, may influence the effectiveness of interventions. Similar interventions may yield different outcomes in settings with limited smartphone access or weak family support. Therefore, FCEM-based interventions should be considered context dependent.

Although adherence to iron supplementation is a critical behavioral outcome, this study did not assess biochemical indicators, such as hemoglobin levels or dietary iron intake. Consequently, conclusions regarding improvements in nutritional status or anemia cannot be directly drawn from these results. While increased adherence is likely to support improved iron status, physiological outcomes could not be confirmed within the scope of the study (Tuncalp et al., 2020). Studies incorporating objective biomarkers provide stronger evidence of the nutritional impact but were beyond the present design.

This study had several limitations. The non-randomized design resulted in baseline group imbalance, particularly regarding anemia status, which may have influenced motivation and adherence. The small sample size and purposive sampling limit generalizability, and reliance on self-reported measures introduces potential recall and social desirability biases. Finally, although reporting inconsistencies were identified during manuscript revision, they were corrected following a careful data review. Future studies should employ randomized or stratified designs, include objective outcome measures, and apply statistical adjustment methods to strengthen the causal inference.

Conclusion

This study found that a digital E-Pocket Book intervention based on the Family-Centered Empowerment Model (FCEM) improved self-efficacy and adherence to iron supplementation among pregnant women compared to standard antenatal education. Nevertheless, these findings should be interpreted with caution due to important methodological limitations, particularly the non-randomized study design and the baseline imbalance in anemia status between groups, which may have influenced the participants' motivation and capacity for behavioral change.

Despite these limitations, the findings suggest that integrating family centered digital education into routine antenatal care may strengthen behavioral support for iron supplementation, especially in primary

healthcare settings. From a practical perspective, the iron supplement E-Pocket Book has the potential to be adopted as a complementary educational tool by community health centers to reinforce counseling and promote family involvement during pregnancy.

Future research should employ randomized or stratified study designs, incorporate objective outcome measures such as hemoglobin levels or dietary iron intake, and examine long-term adherence and scalability to more robustly evaluate the effectiveness and sustainability of FCEM-based digital interventions.

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