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Evaluating E-Healthcare Dietary Interventions via Mobile App for Wound Healing in Post-Caesarean Women: A Quasi-Experimental Study

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ABSTRACT

Background: Optimal wound healing following caesarean delivery is essential for maternal recovery and overall well-being. Although digital health technologies have shown promise in enhancing adherence to dietary interventions, their application in post-caesarean care remains insufficiently investigated. **Objective:** This study aimed to assess the effectiveness of technology-enhanced dietary interventions on wound healing outcomes among women recovering from caesarean delivery. **Methods:** A quasi-experimental study design was employed with 100 post-caesarean women, evenly divided into an intervention group (n=50) and a control group (n=50). The intervention included personalised meal plans, reminders, and educational content on nutrition delivered via the mobile app. Wound healing progress was evaluated using the Wound Healing Progress Assessment Tool (WH-PAT) at baseline and again four weeks post-intervention. Data analysis was performed using paired and independent *t*-tests. **Results:** The intervention group exhibited significantly higher WH-PAT scores post-intervention (mean = 38.6 ± 4.5) compared to the control group (mean = 30.2 ± 5.2, $p < 0.001$). Additionally, the improvement in WH-PAT scores from baseline was notably greater in the intervention group (mean difference = 16.2 ± 3.7, $p < 0.001$) compared to the control group (mean difference=7.2±2.6, $p<0.001$). **Conclusion:** Technology-enhanced dietary interventions markedly improved wound healing outcomes among post-caesarean women. Future studies should investigate the long-term effects and explore ways to optimise these interventions. This intervention supports the integration of sustainable e-health solutions into nursing care protocols for post-operative maternal health.

Keywords: Caesarean Delivery; Dietary Intervention; Mobile Health; Postpartum Care; Wound Healing

INTRODUCTION

The post-caesarean period is a critical phase for wound healing, as surgical recovery significantly impacts a mother's overall health and well-being. Caesarean deliveries constitute a substantial proportion of global childbirths, with rates exceeding 30% in some countries (World Health Organisation, 2021). Effective wound healing after a caesarean section is essential to minimise complications, including infections, prolonged recovery, and scarring, all of which can negatively affect maternal health outcomes (Carbonnel *et al*., 2021). Nutrition plays a pivotal role in wound healing by providing the essential building blocks for tissue repair, immune system function, and overall recovery (Low *et al*., 2023).

Recent technological advancements have facilitated the development of dietary interventions via digital platforms. Mobile applications, wearable devices, and online programs offer personalised nutritional guidance, progress tracking, and reminders, which can enhance adherence to dietary recommendations (Grady *et al*., 2023). These technology-based interventions have demonstrated success in managing chronic conditions such as diabetes and cardiovascular diseases by encouraging healthier behaviours and improving clinical outcomes (Gray *et al*., 2022). Despite their potential, the application of such interventions in the context of wound healing, particularly for post-caesarean women, remains an underexplored area of research.

Wound healing is a multifaceted physiological process encompassing four distinct stages: haemostasis, inflammation, proliferation, and remodelling. Essential nutrients, including proteins, vitamins (A, C, D), and minerals (zinc, iron), are critical for supporting each phase of this process (Ghaly, Iliopoulos & Ahmad, 2021). Research has shown that malnutrition or inadequate nutrient intake can significantly impede wound healing, increasing the risk of infections and delayed recovery (Palmieri, Vadalà & Laurino, 2019). Despite these findings, the consistent integration of evidence-based dietary strategies into post-caesarean care is often overlooked or inconsistently applied.

Digital health technologies have shown promise in improving adherence to nutritional interventions by delivering targeted support such as tracking macronutrient intake or offering culturally tailored diets. For example, Wei *et al*. (2023) demonstrated that a mobile application providing customised dietary plans improved nutritional status and health outcomes in pregnant women. Similarly, Knight *et al*. (2022) emphasised the potential of digital dietary interventions to accelerate recovery and enhance quality of life among surgical patients. However, few studies have specifically explored the role of these technologies in promoting wound healing in post-caesarean populations, leaving this area largely unexplored.

While numerous studies highlight the critical role of nutrition in wound healing, research evaluating the impact of technology-enhanced dietary interventions in this context remains scarce. Current evidence predominantly focuses on general surgical patients or individuals with chronic conditions, with minimal attention paid to post-caesarean populations (Gray *et al*., 2022; Gialdini *et al*., 2024). Furthermore, there is insufficient understanding of how these interventions can be tailored to address the unique nutritional demands and recovery patterns of women following caesarean deliveries. This gap underscores the need for targeted research to assess the effectiveness of digital dietary interventions in improving wound healing outcomes for this specific population.

This quasi-experimental study aims to assess the effectiveness of a technology-enhanced dietary intervention in promoting wound healing among post-caesarean women. By addressing existing knowledge gaps, this study seeks to provide evidence for the integration of digital tools into post-caesarean nutritional care, with the ultimate goal of improving maternal health outcomes.

METHODOLOGY

Study Design

This study employed a quasi-experimental design with pre- and post-intervention assessments to investigate the effects of technology-enhanced nutrition therapy on wound healing in women post-caesarean birth. Participants were categorised into two groups: the intervention group, which received customised dietary support via a technology-based platform, and the control group, which received standard postnatal care without technological enhancements. This approach facilitated the comparison of outcomes between the groups, offering insights into the efficacy of incorporating technology into nutritional management for enhanced wound repair.

Sample

The study focused on women who had recently undergone caesarean delivery, with participants recruited from a hospital in Bekasi, West Java, Indonesia. The inclusion criteria specified that participants had to be women aged 18 to 40 years who were within the first 72 hours post-caesarean delivery. Additionally, participants needed to own a smartphone, demonstrate the ability to use mobile applications, and provide informed consent to participate. Exclusion criteria included the presence of pre-existing chronic conditions such as diabetes or hypertension, complications during surgery, or refusal to use the technology-based intervention.

The sample size was calculated utilising G*Power software (version 3.1.9.7). The study utilised an effect size of 0.5 (Faul *et al*., 2007) and an alpha level of 0.05 to attain enough statistical power (0.80) for identifying significant differences between the intervention and control groups. The minimum requisite sample size was determined to be 100 participants, with 50 persons assigned to each group. The sample size was considered sufficient to guarantee the reliability and validity of the results.

Convenience sampling was implemented as the sampling method, allowing researchers to strategically select participants who met the study's specific criteria. This approach ensured the recruitment of individuals most likely to benefit from and adhere to the intervention. Eligible participants were identified during their hospital stay and provided with detailed information about the study. Informed consent was obtained from those who agreed to participate, underscoring the ethical integrity of the research process.

Instrument

The Wound Healing Progress Assessment Tool (WH-PAT) was utilised as a primary instrument to evaluate wound healing progress in this study. Originally developed by Jeong, Son & Im (2023), the WH-PAT is designed to systematically assess physical parameters associated with wound healing. The instrument has been widely recognised for its comprehensive approach in monitoring wound recovery, making it suitable for both clinical and research applications. The WH-PAT comprises ten items that evaluate various wound characteristics, including size, colour, and the presence of exudate. Each item is scored on a 5-point Likert scale, where 1 indicates poor healing, and 5 represents excellent healing. The total score derived from the tool ranges from 10 to 50, with higher scores signifying better wound healing outcomes. For interpretation, scores are classified into three categories: 10–20, indicating poor healing; 21–30, representing moderate healing; and 31–50, denoting excellent healing. This categorical interpretation allows for a clear understanding of the wound healing trajectory.

The WH-PAT has demonstrated robust psychometric properties. In its original version, the tool showed excellent internal consistency, with a Cronbach's alpha coefficient of 0.91, ensuring reliability in diverse settings. To adapt the tool for this study's context, the WH-PAT was translated into Bahasa Indonesia and validated by local experts. The reliability of the adapted version was confirmed with a Cronbach's alpha of 0.89, indicating its appropriateness for assessing wound healing progress among Indonesian populations.

Procedure

Participants were recruited using predetermined eligibility criteria. Each candidate received detailed information regarding the study's objective, methods, potential dangers, and benefits. Only participants who volunteered to participate and signed a written informed consent form were included in the study.

At the baseline, demographic and clinical information was collected from all participants. Additionally, the Wound Healing Process Assessment Tool (WH-PAT) was administered to evaluate participants' initial status before implementing the intervention. The intervention consisted of two distinct approaches. Participants in the intervention group were given access to a mobile application designed to provide personalised dietary support. The application included features such as dietary guidelines, customised meal plans, automated reminders, and real-time feedback tailored to individual nutritional needs. Conversely, the control group received conventional dietary education materials in printed form, which contained general dietary recommendations without personalisation or interactive elements.

Both groups were monitored for a duration of four weeks. For the intervention group, weekly check-ins were conducted through the mobile application, enabling continuous engagement and support. These interactions allowed researchers to track adherence, address potential issues, and maintain participant involvement throughout the intervention period. At the conclusion of the four-week intervention, a post-intervention assessment was conducted. The WH-PAT was re-administered to all participants to measure changes in wound healing outcomes and compare results between the intervention and control groups. Finally, a feedback collection session was organised with all participants. During this debriefing, participants were encouraged to share their experiences with the intervention. Particular attention was given to the ease of use of the mobile application and its perceived impact on their dietary habits and wound healing progress.

Data Analysis

The data were analysed with SPSS software, version 25. Descriptive statistical approaches were used to summarise the participants' demographic characteristics, such as calculating means, standard deviations, frequencies, and percentages. For comparative analysis, independent t-tests were used to compare scores between the intervention and control groups, while paired *t*-tests were employed to compare changes in scores

within each group before and after the intervention. Statistical significance was defined at $p < 0.05$ to ensure the study's conclusions are robust and relevant.

Ethical Consideration

The researchers obtained ethical clearance from the STIKes Abdi Nusantara's Institutional Review Board (IRB) with the reference number of ETIK-Abnus/2024-178 on 20th March 2024. The study used a methodical approach to ensure ethical compliance, effective participant engagement, and accurate data collecting.

RESULTS

The baseline demographic characteristics of participants in the intervention and control groups show no statistically significant differences, indicating that the groups were comparable before the intervention. Table 1 shows that the mean age was similar between groups (29.8 ± 4.2 years in the intervention group and 30.1 ± 3.9 years in the control group; $p = 0.732$), suggesting no age-related bias. Educational attainment and parity distributions were also balanced, with no significant differences in the proportions of participants with secondary or tertiary education ($p = 0.689$) or between primiparous and multiparous women ($p = 0.701$). This comparability supports the internal validity of the study by reducing the likelihood that baseline demographic factors influenced the outcomes.

Table 1: Baseline Demographic Characteristics of Participants by Group

Characteristic	Intervention Group (n=50)	Control Group (n=50)	*p*-value
Age (mean ± SD, years)	29.8 ± 4.2	30.1 ± 3.9	0.732
Education Level			
Secondary (%)	62%	58%	0.689
Tertiary (%)	38%	42%	
Parity			
Primiparous (%)	32%	36%	0.701
Multiparous (%)	68%	64%	

The independent *t*-test results in Table 2 show a statistically significant difference in post-intervention WH-PAT scores between the intervention and control groups. The intervention group had a higher mean score (38.6 ± 4.5) compared to the control group (30.2 ± 5.2), with a *t*-value of 9.124 and a *p*-value of less than 0.001. This indicates that the intervention had a significant positive effect, leading to improved outcomes as measured by the WH-PAT, suggesting greater post-intervention performance or knowledge in the intervention group (Table 2).

Table 2: Post-Intervention WH-PAT Scores: Independent t-Test Results

Group	Mean ± SD	*t-value*	*p*-value
Intervention Group	38.6 ± 4.5	9.124	<0.001
Control Group	30.2 ± 5.2		

Paired *t*-tests assessed changes in WH-PAT scores within each group before and after the intervention. In the intervention group, the mean WH-PAT score increased significantly from 22.4 ± 5.1 at baseline to 38.6 ± 4.5 after the intervention ($p < 0.001$). Similarly, the control group showed an improvement in scores, but the change was less pronounced, with a mean score of 23.0 ± 5.3 at baseline and 30.2 ± 5.2 post-intervention ($p < 0.001$) (Table 3).

Table 3: Paired t-Test Results for WH-PAT Scores

Group	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Difference ± SD	*t*-value	*p*-value
Intervention Group	22.4 ± 5.1	38.6 ± 4.5	16.2 ± 3.7	24.215	<0.001
Control Group	23.0 ± 5.3	30.2 ± 5.2	7.2 ± 2.6	15.173	<0.001

DISCUSSION

The findings of this study indicate that technology-enhanced dietary interventions significantly improve wound healing outcomes in post-caesarean women, as demonstrated by greater improvements in WH-PAT scores among the intervention group compared to the control group. These results are consistent with the broader body of literature that highlights the vital role of nutrition and technology in promoting wound healing.

For instance, Li *et al*. (2020) reported that personalised dietary interventions supported by digital health tools substantially improved recovery outcomes in surgical patients, emphasizing the potential of integrating technology into clinical care. Similarly, Farinella *et al*. (2024) conducted a meta-analysis showing that digital interventions were associated with improved adherence to nutritional plans and better healing rates in postoperative settings. Additionally, Tinius *et al*. (2021) demonstrated the effectiveness of mobile health applications in enhancing recovery outcomes for postpartum women, further corroborating the benefits of combining technology with dietary management.

Integrating technology into dietary management represents an innovative approach to postpartum recovery, offering tailored nutritional guidance and real-time support (Ball *et al*., 2022). Prior studies have shown the advantages of such interventions in boosting adherence to dietary recommendations and increasing patient engagement (Barnett *et al*., 2023; Raab *et al*., 2023; Rumbo-Rodríguez *et al*., 2020). This study builds on those findings by specifically addressing post-caesarean wound healing—an area that has received limited attention in existing research.

Traditional dietary counselling methods, while beneficial to some extent, often face challenges in maintaining sustained patient engagement (Chen *et al*., 2023; Leonard et al., 2021; Small *et al.*, 2024; Vatsa *et al*., 2025; Wang *et al*., 2025). In contrast, the significant differences in WH-PAT scores between the intervention and control groups observed in this study suggest that incorporating technology can fill this gap by offering more accessible, engaging, and interactive support for postpartum women (Davis *et al*., 2024). Furthermore, the role of technology in promoting long-term adherence to dietary protocols is noteworthy. For example, Jakob *et al*. (2022) and O'Brien *et al*. (2021) have shown that digital interventions not only improve immediate outcomes but also support sustained behavioural changes over time. These findings reinforce the potential of technology to address both short-term recovery goals and long-term health benefits, making it an integral part of postpartum care strategies.

This study has significant clinical implications for nursing practice. It highlights the necessity for healthcare providers to embrace technology-based interventions in postpartum care, particularly for caesarean recovery. Digital tools, including mobile applications, present scalable and cost-effective solutions for offering tailored dietary guidance, thereby alleviating the strain on healthcare systems. Such tools not only support personalised care but also empower patients by fostering independence and enhancing their adherence to recovery regimens, leading to improved health outcomes. From a holistic care perspective, integrating technology into dietary interventions holds the potential to transform postpartum care by addressing both physical recovery and mental well-being. Mobile applications with features like progress tracking and interactive modules can mitigate feelings of isolation and enhance self-efficacy during the recovery process, contributing to better psychological outcomes. These findings underline the importance of incorporating technologically enhanced strategies into nursing practices to provide comprehensive, patient-centred postpartum care.

Limitation

Despite its strengths, this study has limitations that warrant consideration. First, the relatively small sample size may limit the generalisability of the findings. Future research should include larger, more diverse populations to validate these results across different settings and demographics. Second, the study relied on self-reported adherence to dietary recommendations, which is subject to reporting bias. Incorporating objective measures, such as biomarkers of nutritional intake, would strengthen the reliability of future findings. Additionally, the follow-up period was relatively short, focusing primarily on immediate post-caesarean recovery. Future studies should investigate the long-term effects of technology-enhanced dietary interventions on maternal health, including sustained wound healing, nutritional status, and overall well-being. Lastly, varying levels of technological literacy among participants may have influenced the intervention's effectiveness. Addressing this factor in future programme designs, such as by offering technology training or simplified user interfaces, could enhance the accessibility and impact of such interventions.

CONCLUSION

This study demonstrates that technology-enhanced dietary interventions significantly improve wound

healing outcomes in post-caesarean women, offering a promising approach for advancing postpartum care. The findings highlight the potential of digital tools to enhance recovery and overall maternal health by integrating personalised and scalable dietary management strategies. However, addressing the study's limitations and exploring the long-term benefits of these interventions are critical for maximising their impact. By leveraging technology, healthcare providers can deliver more effective, patient-centred care, ultimately improving outcomes for women recovering from caesarean deliveries.

The scope for future research in this area is vast and vital for advancing postpartum care. Future studies could focus on addressing the limitations of the current study, such as the need for larger, more diverse samples and extended follow-up periods to better understand the long-term effects of technology-enhanced dietary interventions. Investigating the integration of these interventions with other postpartum care strategies, such as physical recovery programmes and mental health support, could provide a more comprehensive approach to maternal well-being. Additionally, exploring the use of advanced technologies, including artificial intelligence and machine learning, to further personalise dietary recommendations and optimise recovery trajectories could significantly enhance their efficacy. Expanding these interventions to different cultural contexts and varying healthcare settings would also provide valuable insights into their adaptability and scalability, ultimately paving the way for global improvements in maternal health outcomes.

Conflict of Interest

The authors have no conflicts of interest to declare.

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