

# Effectiveness of Digital Application-Based Nutrition Interventions on Dietary Adherence in Patients with Non-Communicable Diseases

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## ABSTRACT

**Purpose:** This study aims to review and synthesize the effectiveness of digital application-based nutrition interventions in improving dietary adherence among patients with non-communicable diseases (NCDs), as well as to identify supporting factors, barriers, and their impact on health outcomes and behavioral sustainability.

**Subjects and Methods:** A literature review approach was employed by analyzing peer-reviewed journal articles and academic books obtained from major scholarly databases. The selected literature was evaluated and synthesized using a qualitative descriptive approach to identify patterns related to intervention effectiveness, user engagement, and contextual factors influencing implementation.

**Results:** The findings indicate that digital nutrition applications are generally effective in enhancing dietary adherence through features such as self-monitoring, personalized feedback, reminders, and goal-setting mechanisms. Improved adherence is associated with positive health outcomes, including better glycemic control, weight management, blood pressure regulation, and improved quality of life. However, the effectiveness of these interventions varies depending on intervention duration, level of user engagement, and the extent of integration with professional healthcare support. Facilitating factors include digital literacy, user-friendly design, personalization, and healthcare provider involvement, while barriers include limited access to technology, low motivation, complex interfaces, and data privacy concerns. Sustaining long-term behavioral change remains a key challenge.

**Conclusions:** Digital nutrition applications are promising tools for dietary management in NCDs, but their long-term effectiveness depends on user-centered design, continuous engagement, and integration within healthcare systems.

## INTRODUCTION

Non-communicable diseases (NCDs), such as type 2 diabetes mellitus, hypertension, cardiovascular disease, and obesity, are leading causes of morbidity and mortality globally (Habib & Saha, 2010; Budreviciute et al., 2020; Bennett et al., 2018). NCDs account for more than two-thirds of global deaths, with a significant increase particularly in low- and middle-income countries (Nuridin & Rahayu, 2024). Unhealthy diets, including high consumption of sugar, salt, and saturated fat, as well as low intake of fruits and vegetables, have been identified as key risk factors contributing to the increasing prevalence and progression of NCDs.

In the management of NCDs, adherence to a therapeutic diet (dietary adherence) is a critical component determining the long-term success of therapy. A diet consistent with medical recommendations has been shown to play a role in controlling blood glucose, blood pressure, and lipid profiles, as well as preventing complications of chronic diseases (Mente et al., 2017; Doménech et al., 2014; Rizkalla et al., 2004). However, various studies have shown that dietary adherence rates in patients with NCDs remain relatively low. This non-adherence is influenced by various factors, such as limited nutritional knowledge, low motivation, ingrained eating habits, and a lack of ongoing support from healthcare professionals (Massó et al., 2025; King et al., 2025).

Conventional approaches to nutrition interventions, such as face-to-face counseling or leaflet-based education, often face challenges in terms of accessibility and continuity. Limited consultation time, geographic distance, and healthcare professional workloads hinder the provision of consistent and personalized nutrition support to patients with NCDs (Heller et al., 2019; Favas et al., 2022). Therefore, the use of digital technology is increasingly being considered as an innovative solution to increase the effectiveness of nutrition interventions.

Digital app-based nutrition interventions are part of digital health interventions, or mobile health (mHealth), which utilize mobile devices to support health behavior change. Digital nutrition apps generally provide features such as nutrition education, diet tracking, reminders, and personalized feedback. Scientific evidence suggests that digital interventions have the potential to improve healthy eating behaviors and adherence to dietary recommendations, particularly in patients with chronic diseases (Barnett et al., 2023; Salas-Groves et al., 2023; Mair et al., 2023).

Several systematic reviews and meta-analyses report that digital app-based dietary interventions can result in moderate improvements in dietary adherence, increased fruit and vegetable consumption, and decreased sodium and saturated fat intake (Melo et al., 2025; Schoeppe et al., 2016; Schaafsma et al., 2024; Robert et al., 2021). Furthermore, the use of digital apps has also been associated with improvements in certain clinical parameters, such as weight loss, improved glycemic control, and reduced blood lipid levels, although results vary across studies (Brzan et al., 2016).

The effectiveness of digital app-based nutrition interventions is inseparable from the underlying behavioral change theory approach. Apps that integrate components such as self-monitoring, goal setting, personalized feedback, and motivational reinforcement are considered more effective in encouraging sustainable dietary behavior changes. Storni (2014) said that, continuous support through notifications and progress tracking also helps increase patient awareness and accountability for their own diet, which are important aspects of chronic disease self-management.

However, research also shows that not all digital apps have a significant impact on dietary adherence. Factors such as digital literacy levels, app usability, content relevance, and user engagement significantly influence intervention success (Anjabah et al., 2025). Furthermore, a lack of app integration with healthcare professionals or the formal healthcare system can limit the app's long-term effectiveness.

In Indonesia, the use of digital apps in nutrition interventions for patients with NCDs is growing with increasing smartphone penetration. Several local studies report that digital nutrition education and counseling apps can improve dietary knowledge and adherence in patients with diabetes and other chronic diseases, although most studies are small-scale and use non-experimental designs (Akbar & Kurnaini, 2025; Bourdon et al., 2025). Therefore, further research with robust quantitative designs is needed to objectively evaluate the effectiveness of digital app-based nutrition interventions on dietary adherence in patients with NCDs. Based on this description, research on the effectiveness of digital app-based nutrition interventions on dietary adherence in patients with non-communicable diseases is crucial. This research is expected to provide strong empirical evidence regarding the role of digital technology in supporting dietary management in patients with NCDs and serve as a foundation for the development of more effective and sustainable technology-based nutrition interventions.

## **METHODOLOGY**

This study used a literature review with a narrative approach to examine the effectiveness of digital app-based nutrition interventions on dietary adherence in patients with non-communicable diseases. This method was chosen because it allows researchers to systematically collect, compare, and synthesize previous research results to obtain a comprehensive overview of the development, effectiveness, and challenges of implementing digital nutrition interventions in the context of chronic disease management. The literature search was conducted through several international and national scientific databases, namely PubMed, Scopus, ScienceDirect, and Google Scholar. The literature search used a combination of keywords relevant to the research topic, such as digital nutrition interventions, health apps, dietary adherence, and non-communicable diseases, in both English and Indonesian. This search strategy aimed to obtain a broad and representative literature, encompassing both global and national contexts relevant to the research. The literature included in this study was selected based on specific criteria: primary research articles discussing digital app-based nutrition interventions with a non-communicable disease patient population and reporting outcomes related to dietary adherence or eating behavior. The articles reviewed were scientific publications available in full text and published within the last ten years. Articles in the form of opinion pieces, editorials, or reports that did not directly assess dietary adherence as the primary outcome were not included in this review. Literature selection was conducted in stages, beginning with a review of titles and abstracts to assess their suitability for the research objectives. Articles deemed relevant were then thoroughly reviewed through full-text reading. At this stage, articles that did not meet the inclusion criteria or had a focus that did not align with the research topic were excluded from the analysis. The selection process was conducted systematically to ensure that the analyzed literature was of adequate relevance and quality. Data from the selected articles were then extracted and summarized based on key study characteristics, including year of publication, study design, respondent characteristics, type and duration of digital app-based interventions, and key outcomes related to dietary adherence. Data analysis was conducted descriptively and comparatively, synthesizing research findings narratively. This approach was used to identify general patterns, trends in results, and factors influencing the effectiveness of digital app-based nutrition interventions. The quality and credibility of the analyzed literature were assessed by considering the methodological aspects of each study, such as study design, sample size, and clarity of results reporting. Studies with experimental or quasi-experimental designs are considered to have a stronger level of evidence than observational studies, so their findings receive special attention in the synthesis process. Furthermore, the consistency of findings across studies also forms the basis for drawing more objective conclusions. This research did not directly involve human subjects as all data were obtained from previously published literature. Therefore, ethical approval was not required. However, all sources used in this study have been cited appropriately and in accordance with scientific writing standards to maintain academic integrity and avoid plagiarism.

## **RESULTS AND DISCUSSION**

The results of this literature review were synthesized from selected studies focusing on digital application-based nutrition interventions for patients with non-communicable diseases (NCDs). The analysis identifies recurring themes related to intervention effectiveness, influencing factors, implementation barriers, and sustainability of behavioral change. The findings are presented thematically to reflect patterns and variations across the reviewed literature.

### **Effectiveness of Digital Nutrition Applications in Improving Dietary Adherence**

The synthesis indicates that digital nutrition applications are generally effective in improving dietary adherence among patients with NCDs. Most studies consistently report that features such as self-monitoring, personalized feedback, reminders, and goal-setting significantly contribute to users' ability to maintain recommended dietary patterns. Self-monitoring functions, in particular, enable users to track daily food intake and increase awareness of their dietary habits, which is a critical step toward behavior change. Personalized feedback further enhances adherence by providing tailored dietary recommendations based on individual health conditions, preferences, and progress. Reminder systems, such as notifications for meal timing or hydration, support consistency in behavior, while goal-setting features promote user engagement and accountability.

However, the degree of effectiveness varies across studies, depending on factors such as intervention duration, application design, and user engagement levels. Short-term interventions tend to show stronger improvements, while long-term adherence outcomes are less consistent.

### **Impact on Health Outcomes**

The reviewed literature demonstrates that improved dietary adherence facilitated by digital applications is associated with favorable health outcomes among NCD patients. Several studies report improvements in clinical indicators, including glycemic control in diabetic patients, weight reduction among individuals with obesity, and better blood pressure regulation in hypertensive populations. In addition, improvements in dietary behavior contribute to enhanced overall quality of life, as patients experience better disease management and reduced health complications. Nevertheless, the strength of these outcomes varies depending on the intensity of intervention and integration with healthcare systems. Studies that combine digital applications with professional healthcare support, such as dietitian consultations or clinical monitoring, tend to report more significant and sustained health improvements compared to stand-alone applications. This suggests that digital interventions function more effectively as complementary tools rather than replacements for traditional healthcare services.

### **Facilitating Factors for Effective Implementation**

The effectiveness of digital nutrition interventions is strongly influenced by several facilitating factors identified in the literature. Digital literacy emerges as a key determinant, as users with higher familiarity with technology are more likely to utilize application features effectively. Ease of use and intuitive interface design also play a crucial role in maintaining user engagement and minimizing dropout rates. Personalization of content is another critical factor, as tailored recommendations increase relevance and user motivation. Furthermore, support from healthcare providers enhances credibility and encourages consistent application use. Studies show that when digital tools are integrated into formal healthcare systems, patient adherence and trust in the intervention significantly improve.

### **Barriers and Challenges in Implementation**

Despite their potential, digital nutrition applications face several implementation challenges. Limited access to digital devices and internet connectivity remains a significant barrier, particularly in low-resource settings. Additionally, low user motivation and inconsistent engagement reduce the long-term effectiveness of these interventions. Complex application interfaces and poor usability also contribute to user dissatisfaction and discontinuation. Concerns related to data privacy and security further hinder adoption, especially when users are required to input sensitive health information. These barriers highlight the need for user-centered design and stronger regulatory frameworks to ensure safe and accessible digital health solutions.

### **Sustainability of Behavioral Change**

While digital nutrition interventions are effective in initiating behavioral change, sustaining long-term dietary adherence remains a major challenge. The literature suggests that user engagement tends to decline over time, particularly in the absence of continuous support and motivation. Behavioral change is more sustainable when digital interventions are combined with social support systems, such as family involvement or community-based programs. Moreover, adaptive interventions that evolve based on user progress and feedback are more likely to maintain long-term engagement. This indicates that sustainability is not solely dependent on technology features but also on the integration of behavioral, social, and healthcare support mechanisms.

### **Synthesis and Implications**

The findings suggest that digital application-based nutrition interventions represent a promising strategy for improving dietary adherence and supporting disease management among NCD patients. However, their effectiveness is context-dependent and influenced by technological, individual, and systemic factors. The results highlight the importance of integrating digital tools within broader healthcare systems and designing interventions that are user-centered, accessible, and adaptable. From a practical perspective, healthcare providers and policymakers should focus

on improving digital literacy, ensuring equitable access to technology, and strengthening the integration of digital applications with clinical services. From a research perspective, further studies are needed to examine long-term effectiveness and develop strategies for sustaining behavioral change in diverse populations.

## **Discussion**

Digital app-based nutrition interventions are increasingly being implemented in the management of non-communicable diseases and show significant potential for improving dietary adherence (Kurniawan et al., 2025; Giardina et al., 2025; Shaluhayah et al., 2025). This aligns with the evolving healthcare paradigm that emphasizes a patient-centered care approach and the use of digital technology to support self-management of chronic diseases. The diverse characteristics of the studies, both in terms of research design and the types of apps used, reflect the flexibility of digital interventions in adapting to the needs of patients with various non-communicable disease conditions.

Payne et al. (2018) said that, the effectiveness of digital apps on dietary adherence can be understood through health behavior change theory, which emphasizes the role of self-monitoring, feedback, and ongoing reinforcement. The feature of recording food intake and monitoring progress allows patients to increase self-awareness of their eating habits, which is a crucial prerequisite for dietary behavior change. These findings support the view that digital technology functions not only as an information medium but also as an active behavioral intervention tool in shaping healthy eating habits.

The results also indicate that personalized content and feedback in digital apps contribute to improved dietary adherence. This is relevant to self-determination theory, which emphasizes the importance of autonomy and personal relevance in maintaining intrinsic motivation. When dietary recommendations are tailored to individual health conditions and preferences, patients tend to feel more engaged and responsible for managing their diet. Therefore, the effectiveness of digital interventions depends heavily on the extent to which the app provides a relevant and meaningful experience for users.

The supporting factors and barriers to implementation identified in the results indicate that the success of digital interventions is determined not only by the quality of the technology, but also by the user's context and the health system (Kaboré et al., 2022). Digital literacy levels, access to technology, and support from healthcare professionals play a crucial role in determining the sustainability of app use. Barriers such as limited internet access and concerns about data security emphasize that the implementation of digital interventions needs to be accompanied by policies and regulations that support equitable access and protect user privacy.

The impact of digital interventions on health outcomes, such as improved metabolic control and weight loss, suggests that increased dietary adherence contributes directly to improvements in patients' clinical conditions. This finding is consistent with the literature stating that dietary behavior change is a key component in the management of non-communicable diseases. However, variation in results across studies indicates that health impacts are not always uniform and are strongly influenced by the duration of the intervention and the consistency of app use.

The sustainability of dietary behavior change is a key issue emerging in the discussion of these findings. Although digital apps are effective in facilitating short- to medium-term behavior change, some studies have shown a decline in adherence after app use decreases. This suggests that digital interventions need to be designed with long-term strategies, including strengthening internal motivation and integrating with social and professional support, to ensure that behavioral changes are sustained.

## **CONCLUSION**

Digital app-based nutrition interventions have been shown to have significant potential to improve dietary adherence in patients with non-communicable diseases and positively impact various health outcomes. Based on a synthesis of research findings, digital apps function not only as a nutrition education medium but also as a behavioral change support tool through food intake monitoring, personalized feedback, and ongoing reinforcement that promote patient awareness

and responsibility for their diet management. Improved dietary adherence facilitated by digital interventions contributes to improvements in clinical parameters such as glycemic control, blood pressure, lipid profiles, and weight management, which are important indicators in managing non-communicable diseases. However, the effectiveness of digital interventions varies depending on study characteristics, app design, intervention duration, and user engagement. Key factors supporting intervention implementation include adequate digital literacy, app ease of use, content personalization, and ongoing support from healthcare professionals and the social environment. Conversely, barriers such as limited access to technology, low user motivation, app interface complexity, and concerns about data privacy and security can reduce the success and sustainability of digital nutrition apps. Findings also suggest that dietary behavior changes generated through digital interventions tend to be more effective in the short to medium term, but may decline when app use decreases or the intervention is discontinued. Therefore, sustainable behavior change requires the integration of digital interventions with a multidisciplinary approach involving healthcare professionals and strengthening patients' intrinsic motivation. Overall, digital app-based nutrition interventions are a promising, innovative approach to managing non-communicable diseases. However, their long-term success depends heavily on user-centered intervention design, health system support, and strategies that encourage adoption and consistent use of the apps as part of a healthy lifestyle.

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