

DIGITAL NURSING INTERVENTIONS FOR IMPROVING MEDICATION ADHERENCE AND SELF-MANAGEMENT AMONG PATIENTS WITH CHRONIC DISEASES

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Article Info

Article History:

Received: January 8, 2025

Accepted: February 13, 2025

Published: March 28, 2025

Abstract

Chronic diseases require sustained medication adherence and proactive daily self-management, yet patients frequently encounter barriers such as limited health literacy and fragmented clinical follow-up. This study evaluated a nurse-led digital intervention incorporating mobile medication reminders, tailored health education, vital-sign monitoring, goal setting, and asynchronous clinical feedback. Using a quasi-experimental pretest-posttest design with a simulated dataset of 240 primary care adults with hypertension, type 2 diabetes, or chronic heart failure, participants were allocated to a 12-week digital nursing program or standard care. The digital intervention group demonstrated significant improvements in medication adherence, self-efficacy, and self-management behaviors compared to usual care, alongside notable gains in blood pressure and glycemic control. While higher digital literacy accelerated user adoption, structured nursing support remained essential for older participants. Overall, digital tools effectively augment relational nursing workflows and patient-centered chronic care.

Keywords:

Keyword 1; Digital nursing

keyword 2; Telenursing

keyword 3; Self-management

keyword 4; Chronic Diseases

keyword 5; Medication

adherence

Abstrak

Penyakit kronis menuntut kepatuhan pengobatan jangka panjang dan manajemen diri yang konsisten, namun sering kali terkendala oleh literasi kesehatan yang terbatas serta tindak lanjut klinis yang terfragmentasi. Penelitian ini mengevaluasi intervensi keperawatan digital berbasis aplikasi yang mengintegrasikan pengingat obat, edukasi terarah, pemantauan tanda vital, penetapan target mandiri, dan umpan balik asinkron dari perawat. Melalui desain kuasi-eksperimental pretest-posttest pada data simulasi 240 pasien rawat jalan dengan hipertensi, diabetes tipe 2, atau gagal jantung kronis, responden dibagi ke dalam program keperawatan digital selama 12 minggu atau perawatan konvensional. Kelompok intervensi menunjukkan peningkatan signifikan pada kepatuhan terapi, efikasi diri, dan perilaku pengelolaan mandiri, disertai stabilitas tekanan darah dan indikator glikemik yang lebih baik. Temuan ini menegaskan bahwa inovasi digital paling efektif ketika terintegrasi langsung dalam asuhan keperawatan relasional untuk mengoptimalkan luaran klinis pasien kronis.

Kata Kunci:

Kata kunci 1; keperawatan digital

kata kunci 2; Kepatuhan

pengobatan

kata kunci 3; Manajemen diri

kata kunci 4; Penyakit kronis

kata kunci 5; Keperawatan jarak

jauh

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How to cite: Diransyah, Y., Yuliana, E., & Utama, P. (2025). DIGITAL NURSING INTERVENTIONS FOR IMPROVING MEDICATION ADHERENCE AND SELF-MANAGEMENT AMONG PATIENTS WITH CHRONIC DISEASES. *Aspiration of Health Journal*, 3(1), 1–9. <https://doi.org/10.55681/aohj.v3i1.561>



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INTRODUCTION

Chronic diseases are responsible for prolonged treatment demands that extend far beyond episodic clinical encounters. Patients must remember medicines, interpret symptoms, monitor physiological indicators, modify lifestyle behaviors, and communicate emerging problems to professionals. Medication nonadherence therefore reflects more than forgetfulness; it can arise from regimen complexity, treatment burden, low confidence, adverse effects, limited understanding, and discontinuity of support. Digital health offers new channels for sustained contact, but technology alone does not guarantee behavioral change. Reviews of mobile interventions show that adherence effects vary according to intervention design, patient population, and intensity of support (Arshed et al., 2023; Georgieva et al., 2023). This variability creates a strong rationale for nursing models that combine digital tools with individualized assessment, education, motivation, and follow-up.

Nurses occupy a central position in chronic disease management because they routinely translate treatment plans into practical daily behaviors. Digital nursing extends this function through mobile applications, secure messaging, telemonitoring, video education, and remote coaching. Evidence indicates that nurse-led digital approaches can improve self-management outcomes when patients receive timely interpretation of health information and clinically meaningful feedback rather than generic automated messages. Hwang and Chang (2023) reported beneficial effects of nurse-led digital health interventions for hypertension management, while Zhang et al. (2024) found that nurse-led electronic health interventions can strengthen illness management in chronic heart failure. These findings suggest that the distinctive contribution of digital nursing lies in combining technological reach with therapeutic communication, clinical judgment, and continuity of care across home and primary-care environments.

Medication adherence is particularly suitable for digitally supported nursing because medication-taking is repetitive, measurable, and responsive to behavioral cues. Mobile reminders can reduce unintentional omission, while digital medication logs can help nurses identify recurring patterns of missed doses. However, reminder fatigue may develop when messages are repetitive or poorly timed. Mikulski et al. (2022) showed that mobile health applications can support adherence among people with hypertension, although effectiveness depends on intervention characteristics. O'Hara et al. (2022) similarly emphasized that digital technologies for chronic kidney disease should address the complex barriers and enablers influencing adherence. Consequently, effective nursing interventions should move beyond alarm functions toward personalized problem solving, side-effect assessment, regimen clarification, and reinforcement of patients' reasons for maintaining treatment. Self-management is broader than medication adherence and includes symptom recognition, lifestyle modification, monitoring, decision making, and appropriate use of healthcare services. Digital platforms can integrate these tasks within a single patient-facing environment, allowing patients to record blood pressure, glucose, symptoms, activity, or medication intake and receive tailored feedback. Verweel et al. (2023) found that digital interventions can improve health literacy-related outcomes among people living with chronic diseases, an important pathway for stronger self-management. Tarricone et al. (2024) further demonstrated that mobile diabetes interventions are more effective when they incorporate purposeful behavior-change techniques. For nursing practice, these findings highlight the importance of structuring digital content around achievable goals, feedback, self-monitoring, and problem solving rather than simply transferring printed educational material onto a screen.

Patient engagement is another determinant of whether digital nursing produces sustained benefit. Patients may download or enroll in digital programs but gradually reduce interaction when interfaces are difficult, content lacks relevance, or feedback is delayed. Eaton et al. (2024a) found substantial variation in how engagement is defined and measured across mHealth interventions for adherence and self-management. Their work indicates that exposure to technology should not be equated with meaningful engagement. A clinically useful digital nursing model should therefore monitor both outcome data and patterns of use, including missed entries, unread messages, and declining participation. Nurses can use these signals to initiate supportive contact, simplify goals, or modify the communication strategy, thereby transforming engagement data into actionable nursing information rather than passive platform analytics.

The selection of behavior-change components also influences intervention effectiveness. Cross-condition evidence suggests that self-monitoring, prompts, feedback, goal setting, action planning, and social or professional support are recurring components of successful mHealth programs (Eaton et al., 2024b). These techniques align closely with established nursing activities such as assessment, education, motivational communication, and reinforcement. The digital environment can increase their frequency and responsiveness, but it also creates risks related to information overload and dependence on automated prompts. For patients with multimorbidity, the challenge is greater because several medications, symptoms, and lifestyle recommendations must be coordinated simultaneously. A nurse-led system can prioritize tasks, interpret conflicting information, and help patients establish realistic routines that reflect personal capacity, preferences, and treatment priorities.

Digital equity must be considered when introducing technology into chronic care. Older adults, people with limited education, low digital literacy, unstable internet access, visual impairment, or limited confidence with smartphones may experience barriers that reduce intervention exposure and widen disparities. Birhanu et al. (2024) found that use of mobile health applications for diabetes self-management remains uneven, despite substantial future interest. Kilfoy et al. (2025) likewise concluded that nurse-led remote digital support can improve outcomes across chronic conditions, while intervention characteristics and patient context remain important. Inclusive digital nursing should therefore offer simple navigation, clear language, flexible communication channels, caregiver involvement when appropriate, and non-digital alternatives for patients who cannot or do not wish to use mobile tools.

Despite expanding evidence, there remains a need for integrated studies that evaluate medication adherence and broader self-management within one nurse-led digital model across common chronic diseases. Many interventions focus on a single diagnosis or isolated technology, limiting understanding of how nursing support, patient engagement, and self-monitoring operate together. This study therefore evaluates a twelve-week digital nursing intervention combining personalized medication reminders, tailored education, symptom and vital-sign monitoring, weekly self-management goals, and asynchronous nurse feedback. The objectives are to examine changes in medication adherence, self-management capacity, self-efficacy, engagement, and selected clinical indicators, and to identify patient characteristics associated with stronger response. The study uses a transparent simulated dataset to demonstrate an analytically coherent research model without presenting synthetic observations as real patient records.

METHOD

This study used a quasi-experimental pretest-posttest design with an intervention and comparison group. The analytical dataset was explicitly simulated for methodological demonstration and contained 240 adults receiving primary healthcare for hypertension, type 2 diabetes, or chronic heart failure, with 120 participants in each group. Eligibility criteria represented adults aged 30 years or older, prescribed at least one long-term medication, able to communicate by mobile phone, and clinically stable for community management. The intervention lasted twelve weeks. Research design, operationalization of variables, sampling logic, and quantitative comparison were structured according to Indonesian methodological guidance emphasizing alignment between research questions, measurement, and statistical analysis (Sugiyono, 2022). Because no real patients were recruited, no claim of actual clinical effectiveness or institutional ethical approval is made from the simulated observations.

The intervention combined five nurse-led components: personalized medication reminders; short educational modules tailored to diagnosis and treatment barriers; patient-entered monitoring of medication intake, symptoms, blood pressure or glucose when relevant; weekly self-management goal setting; and secure asynchronous nurse feedback. Nurses reviewed submitted information on working days and used a standardized escalation algorithm for simulated warning signs. The comparison group represented usual chronic-care follow-up without the integrated digital package. Medication adherence was modeled using an eight-item adherence score, while self-management and self-efficacy were represented by standardized multi-item scales. Engagement was summarized

from weekly completion of monitoring tasks and message interaction. The nursing process underlying assessment, intervention planning, implementation, and evaluation followed principles described in Indonesian nursing research methodology, particularly the need for valid operational definitions and systematic measurement (Nursalam, 2020).

Descriptive statistics summarized participant characteristics and outcome distributions. Baseline comparability was assessed using independent-samples tests for continuous variables and chi-square tests for categorical variables. Intervention effects were estimated from pre-post change scores and multivariable linear regression adjusted for age, sex, diagnosis, baseline outcome level, number of prescribed medicines, and digital literacy. Subgroup analyses explored whether engagement and baseline digital literacy modified response. Statistical significance was defined at $p < 0.05$, while effect sizes and confidence intervals were emphasized to avoid reliance on significance testing alone. Internal consistency for modeled scales was set within acceptable psychometric ranges. The simulated analysis was designed to illustrate a plausible evaluation framework consistent with contemporary digital-health research, not to substitute for prospectively collected clinical evidence. Future application would require ethical review, informed consent, data-protection procedures, and prospective registration.

RESULTS AND DISCUSSION

Outcome	Intervention: baseline → week 12	Usual care: baseline → week 12	Modeled interpretation
Medication adherence	5.3 → 7.1	5.4 → 5.9	Greater improvement
Self-management	61.8 → 75.6	62.4 → 65.7	Greater improvement
Self-efficacy	64.2 → 76.8	64.7 → 67.1	Greater improvement
SBP, hypertension subgroup	142.7 → 134.1 mmHg	142.1 → 139.0 mmHg	Larger reduction

The simulated sample included 240 adults with a mean age of 58.4 years, and 55.0% were women. Hypertension was the most common index condition, followed by type 2 diabetes and chronic heart failure. Baseline medication adherence, self-management, self-efficacy, number of medicines, and digital literacy were comparable between groups, supporting interpretation of subsequent change as an intervention-associated pattern within the modeled dataset. After twelve weeks, the digital nursing group showed a larger increase in adherence than usual care, with the mean adherence score rising from 5.3 to 7.1 compared with 5.4 to 5.9. This direction is consistent with systematic evidence that mHealth interventions can improve medication adherence in cardiovascular populations, although effects vary across intervention.

Improvement in medication adherence was not limited to participants who began with the lowest scores. Moderate-adherence participants also demonstrated meaningful gains, suggesting that digital nursing may reinforce established routines as well as correct problematic ones. The adjusted between-group difference in adherence change remained statistically significant after controlling for demographic and clinical covariates. This modeled result corresponds with evidence from Mikulski et al. (2022), who reported beneficial effects of mobile applications on medication adherence among people with hypertension. However, the present framework adds active nursing interpretation and feedback to the digital platform. This distinction is important because reminders primarily address prospective memory, whereas nurse communication can address beliefs, adverse effects, confusion, treatment burden, and competing priorities that commonly contribute to intentional.

Self-management capacity improved from a modeled mean of 61.8 to 75.6 in the intervention group, compared with a smaller increase from 62.4 to 65.7 under usual care. Participants most frequently improved in medication organization, symptom observation, appointment preparation, and use of home-monitoring information. The pattern supports the concept that digital nursing should connect individual tasks into a coherent self-management routine. Kilfoy et al. (2025) synthesized trials of nurse-led remote digital support and identified positive effects across self-management, clinical outcomes, healthcare use, and satisfaction. The current model similarly treats nursing contact as a coordinating mechanism rather than an optional feature. When nurses respond to patient-generated information, monitoring becomes a communication process that can strengthen interpretation, confidence, and.

Self-efficacy increased more strongly among digitally supported participants, particularly for confidence in maintaining medication schedules during changes in routine and responding

appropriately to symptom fluctuations. This finding is clinically relevant because patients with chronic diseases repeatedly make decisions outside healthcare facilities. Digital tools can provide prompts, but sustained self-management requires confidence to translate information into action. Verweel et al. (2023) reported that digital interventions can improve health literacy and related skills in chronic disease populations, providing a plausible mechanism for improved confidence. In the modeled intervention, educational modules were deliberately short and linked to patient-entered data. This design allowed information to be presented near the moment of need. Nurse feedback then contextualized the content, reducing the risk that patients would.

Engagement emerged as an important explanatory variable. Participants completing at least 80% of weekly monitoring tasks had larger adherence and self-management gains than those with lower completion. Frequent but purposeful interaction with nurse messages was also associated with stronger outcomes. These results align with Eaton et al. (2024a), who emphasized that engagement with mHealth interventions is multidimensional and inconsistently measured. Counting log-ins alone may therefore underestimate meaningful participation. In nursing practice, engagement should include whether patients complete relevant tasks, understand feedback, communicate barriers, and act on agreed goals. The modeled data also showed that engagement declined slightly after week eight, indicating a potential novelty effect. Periodic personalization, revised goals, and reduced message frequency for stable patients may help sustain participation.

The behavior-change architecture of the intervention appeared to complement nursing practice. Medication reminders supported cueing, self-monitoring generated awareness, weekly goals promoted action planning, and nurse feedback reinforced progress or addressed barriers. Eaton et al. (2024b) identified several cross-cutting behavior-change techniques that recur in mHealth interventions for adherence and self-management across complex medical conditions. The present framework operationalized these techniques within a nurse-patient relationship rather than as isolated software features. This integration is important because the same technique may have different meanings across diagnoses. For example, a reminder for antihypertensive medication may require minimal explanation, whereas medication changes in heart failure may interact with symptoms, weight, blood pressure, and diuretic timing. Nursing oversight allows digital prompts to remain clinically contextualized and.

Among participants with hypertension, the intervention group showed a modeled mean reduction in systolic blood pressure of 8.6 mmHg compared with 3.1 mmHg in usual care. Although the study was not designed to establish causal clinical efficacy, the pattern is compatible with evidence that nurse-led digital interventions can support blood pressure management. Hwang and Chang (2023) found that nurse-led digital health interventions improved blood pressure outcomes and self-management among people with hypertension. Medication adherence is one plausible pathway, but improved monitoring, dietary awareness, physical activity, and earlier communication may also contribute. These multiple pathways illustrate why adherence should not be evaluated in isolation. A digital nursing program can influence a network of behaviors, and clinical indicators may reflect.

Participants with type 2 diabetes demonstrated a modeled reduction in HbA1c that was larger in the digital nursing group than in usual care. The intervention did not focus exclusively on glycemic control; instead, it linked medication routines with monitoring, dietary goals, symptom awareness, and nursing feedback. Tarricone et al. (2024) found that mobile applications using behavior-change techniques can improve diabetes self-management outcomes, while Sun et al. (2024) reported convincing or highly suggestive evidence for selected mobile-phone interventions across chronic diseases, including glycemic and adherence outcomes. The present pattern reinforces the value of multicomponent support. For diabetes, medication adherence interacts with diet, activity, glucose monitoring, and treatment adjustment. Digital nursing may be especially useful when it helps patients interpret these interdependencies.

For chronic heart failure, modeled improvements were most apparent in daily medication organization, symptom recognition, and weight-monitoring consistency. Hospitalization was not evaluated because the simulated sample and twelve-week period were not appropriate for reliable event-rate estimation. Nevertheless, the self-management pattern corresponds with the review by

Zhang et al. (2024), which found that nurse-led electronic health interventions can improve illness management among patients with chronic heart failure. Remote nursing is particularly relevant to heart failure because subtle changes in symptoms and weight may require timely interpretation. A digital system can make changes visible earlier, while nursing judgment can determine whether reassurance, education, medication review, or escalation is appropriate. This combination illustrates the clinical advantage of integrating remote monitoring with accountable professional.

Digital literacy modified the magnitude of improvement. Participants with higher baseline digital literacy engaged earlier and completed more monitoring tasks, whereas those with lower literacy required more onboarding and had slower initial gains. By week twelve, however, the gap narrowed among participants who received repeated nurse guidance. Birhanu et al. (2024) reported that current use of mobile health applications for diabetes self-management remains limited relative to expressed future interest, underscoring the importance of usability and support. Digital nursing programs should therefore assess capability before enrollment and provide graduated assistance. Simple interfaces, visual instructions, demonstration sessions, and alternative channels such as text messaging can reduce barriers. Excluding patients because they initially lack digital confidence would contradict the equity goals of primary.

Age was associated with engagement but did not eliminate intervention benefit after adjustment for digital literacy. Older participants tended to use fewer optional application features, yet many consistently completed core medication and monitoring tasks when navigation was simplified. This distinction suggests that comprehensive feature use is not necessary for clinical value. Digital interventions should prioritize essential functions and allow patients to choose communication modes. Georgieva et al. (2023) concluded that digital solutions for diabetes medication adherence require personalization and support across medication-use phases. A similar principle applies across chronic diseases: effective technology should adapt to patient routines rather than requiring patients to adapt to unnecessary complexity. Nurses can identify which functions are clinically important for each individual, reducing cognitive burden.

The intervention also illustrates the importance of personalized feedback. Automated reminders were standardized initially, but nurses could adjust timing, educational content, and weekly goals in response to modeled patient needs. Moon and Walsh (2025) noted that digital adherence interventions show mixed effects and that many programs fail to produce sustained improvement, highlighting the need to understand successful design characteristics. Personalization may reduce habituation to repetitive notifications and increase perceived relevance. In the present framework, feedback was intentionally brief, actionable, and linked to recent patient data. This approach can preserve nursing workload while maintaining a sense of human responsiveness. Future real-world trials should compare fully automated, nurse-supported, and adaptive hybrid models to determine which components provide sufficient incremental benefit to justify.

Safety and privacy are central to digital nursing because patient-generated data may include medication use, symptoms, physiological measures, and sensitive communications. The modeled intervention used role-based access, minimum necessary data fields, and an escalation protocol for warning signs. O'Hara et al. (2022) emphasized that digital adherence technologies should be implemented with attention to clinical workflow and patient-specific barriers, while Du and Zhao (2025) highlighted broader applicability and long-term considerations for digital adherence interventions. A nursing service must clearly communicate which data are monitored, how quickly messages are reviewed, and what patients should do during emergencies. Without these boundaries, patients may assume continuous surveillance and delay urgent care. Digital convenience therefore requires explicit governance, cybersecurity safeguards, informed consent, and realistic expectations.

The findings also have implications for interprofessional chronic-care delivery. Nurses can coordinate adherence assessment and self-management coaching while communicating medication-related concerns to physicians and pharmacists. Christy et al. (2025) showed that pharmacist-led digital interventions can support diabetes management, illustrating that digital care is not restricted to one profession. A collaborative model may be especially useful for polypharmacy, suspected adverse effects, or complex regimen changes. Nursing-generated adherence data can

inform medication reconciliation, while pharmacists can address regimen optimization and physicians can evaluate clinical response. Interoperability is therefore more important than creating profession-specific digital silos. Future systems should enable structured information exchange while preserving accountability for review and action. Such integration could transform patient-generated data into coordinated clinical decisions rather than accumulating.

Overall, the modeled results suggest that digital nursing is most promising when technology amplifies relational care, behavioral support, and clinical interpretation. Digital tools can increase the frequency of contact, but the value of that contact depends on relevance, usability, and appropriate professional response. Zhang et al. (2025) found that digital interventions improved several dimensions of treatment adherence in dialysis populations, although certainty varied across outcomes. This caution is applicable to the present study: simulated results demonstrate a coherent evaluation model, not definitive effectiveness. Real-world trials should use adequately powered randomized designs, objective adherence measures where feasible, longer follow-up, implementation outcomes, cost analyses, and subgroup evaluation. Research should also examine whether benefits persist after active nurse contact is reduced and whether.

CONCLUSION

This study presents a structured model of digital nursing for chronic disease management that integrates medication reminders, tailored education, self-monitoring, goal setting, and nurse feedback. Within the simulated dataset, the intervention was associated with stronger improvement in medication adherence, self-management capacity, and self-efficacy than usual care, with favorable patterns in selected clinical indicators. The findings support the proposition that digital tools are most valuable when they extend nursing assessment, communication, and behavioral support rather than replacing professional relationships with automated notifications.

Engagement and digital literacy were important determinants of response. Patients who consistently completed monitoring activities and interacted with nurse feedback achieved greater modeled improvement, while participants with lower digital literacy required additional onboarding and simplified pathways. Digital nursing should therefore be designed around accessibility, personalization, privacy, and clear escalation procedures. Programs should preserve non-digital alternatives and avoid assuming that smartphone ownership is equivalent to digital readiness. These considerations are essential for ensuring that technology strengthens rather than widens equity in chronic disease care.

Because the dataset was simulated, the numerical findings must not be interpreted as evidence from actual patients. The study instead provides a reproducible conceptual and analytical framework for future empirical evaluation. Prospective multicenter trials should assess objective medication-taking behavior, patient-reported outcomes, clinical indicators, safety, workload, cost-effectiveness, and long-term sustainability. Comparative studies of automated versus nurse-supported models would also clarify the incremental contribution of professional feedback. With rigorous evaluation and responsible implementation, digital nursing may become an important component of continuous, patient-centered chronic disease management.

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