



## Design and implementation of a mobile health-enabled community nursing framework for enhancing patient monitoring and care delivery in low-resource settings

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### Abstract

#### Background

Chronic diseases pose a significant burden in low-resource settings, where limited healthcare access and inadequate monitoring systems hinder effective disease management. Mobile health (mHealth) technologies offer promising solutions to enhance patient care through real-time monitoring and improved accessibility.

#### Objective

This study aimed to design and implement a mobile health-enabled community nursing framework to improve patient monitoring and care delivery in low-resource settings.

#### Methods

A quantitative quasi-experimental pre-post intervention study was conducted among 750 patients with chronic conditions. The intervention included a mobile health application, nurse-led monitoring, and patient self-management support. Data were collected at baseline and after six months, and analyzed using descriptive statistics, paired t-tests, and regression analysis.

#### Results

Significant improvements were observed in clinical outcomes, including reductions in systolic blood pressure and blood glucose levels ( $p < 0.001$ ). Medication adherence and self-management behaviors also improved substantially. High user engagement and system usability were reported. Regression analysis indicated that mobile app usage and nurse-led interventions were significant predictors of improved outcomes.

#### Conclusion

The mobile health-enabled community nursing framework effectively enhances patient monitoring, adherence, and clinical outcomes in low-resource settings. The integration of digital health technologies with community nursing practices offers a scalable and sustainable approach to improving healthcare delivery.

**Keywords:** Mobile health, community nursing, chronic disease management, patient monitoring, low-resource settings, mHealth, self-management

### Introduction

Healthcare delivery in low-resource and rural settings continues to face significant challenges, including limited access to healthcare services, workforce shortages, and persistent health disparities. Rural populations often experience higher burdens of chronic disease and reduced access to preventive and curative services compared to urban counterparts (Centers for Disease Control and Prevention, 2020) [4]. These disparities are further exacerbated by socio-economic inequalities and cultural barriers that hinder equitable healthcare utilization (Anderson *et al.*, 2003; Chen *et al.*, 2016) [5].

Community health nursing has emerged as a critical strategy in addressing these gaps by delivering population-centered care, promoting health education, and facilitating early disease detection at the grassroots level. Community health nurses play a vital role in rural health promotion through outreach programs, patient education, and coordination of care services (Brown & Smith, 2018) [3]. However, traditional models of community-based care often face operational limitations, including geographic barriers, inadequate infrastructure, and insufficient real-time patient monitoring capabilities (Curtis & Patel, 2017) [6].

Recent advancements in digital health technologies, particularly mobile health (mHealth), offer promising solutions to overcome these challenges. MHealth

interventions, including mobile applications and remote monitoring tools, have demonstrated effectiveness in extending healthcare access and improving service delivery in underserved populations. For instance, mobile health clinics and digital outreach programs have shown potential in reaching remote communities and enhancing continuity of care (Foster & Campbell, 2019) [9]. Furthermore, participatory approaches such as community-based participatory research emphasize the importance of engaging local populations in the design and implementation of healthcare interventions, thereby improving acceptance and sustainability (Gentry & Grady, 2016) [10].

Despite these advancements, there remains a critical need to integrate mHealth technologies with community nursing frameworks in a structured and scalable manner. Existing healthcare systems often lack culturally competent, technology-enabled models that can support continuous patient monitoring and data-driven decision-making (Anderson *et al.*, 2003) [2]. Leadership and organizational transformation within nursing practice are also essential to effectively adopt and sustain digital health innovations in low-resource settings (Dower *et al.*, 2013) [7].

Therefore, this study proposes the design and implementation of a mobile health-enabled community nursing framework aimed at enhancing patient monitoring

and care delivery in low-resource settings. By combining the strengths of community nursing with real-time digital health technologies, the proposed framework seeks to improve healthcare accessibility, efficiency, and patient outcomes while addressing existing systemic and contextual challenges.

## Review of Literature

The growing burden of noncommunicable diseases (NCDs) continues to pose a major challenge to healthcare systems, particularly in low-resource settings. NCDs not only impact individual health outcomes but also impose significant economic strain on households and national economies, highlighting the urgent need for cost-effective and scalable healthcare interventions (Engelgau *et al.*, 2011)<sup>[8]</sup>. Effective management of chronic diseases requires long-term adherence to treatment and sustained behavioral modifications, which remain difficult to achieve in traditional care models.

Medication adherence is a critical component of chronic disease management. A systematic review by Viswanathan *et al.* (2012) emphasized that multifaceted interventions, including patient education and behavioral support, are essential to improve adherence to self-administered medications. Similarly, Allegrante *et al.* (2019)<sup>[1]</sup> highlighted the importance of behavioral self-management strategies in enhancing patient engagement and improving health outcomes. These findings underscore the need for continuous monitoring and patient-centered interventions, particularly in community-based care settings.

In recent years, mobile health (mHealth) technologies have emerged as a promising approach to address these challenges. Evidence suggests that mHealth applications significantly enhance self-management behaviors among individuals with chronic conditions by providing real-time feedback, reminders, and health education (Wang *et al.*, 2021)<sup>[15]</sup>. Supporting this, Hamine *et al.* (2015)<sup>[11]</sup> demonstrated through a systematic review that mHealth interventions improve treatment adherence and clinical outcomes, making them valuable tools in chronic disease management.

Further advancements in digital health interventions have focused on usability and patient engagement. Kristjansdottir *et al.* (2020)<sup>[12]</sup> reported that mobile applications designed to support patient reflection and self-management are both feasible and effective, particularly when tailored to user needs. Additionally, Zanaboni *et al.* (2018)<sup>[1]</sup> emphasized the importance of robust evaluation methods to assess the effectiveness, usability, and scalability of internet-based and mobile health interventions.

Community-based healthcare approaches, combined with digital tools, have shown significant potential in improving chronic disease management. Nugent (2019)<sup>[13]</sup> highlighted that prevention and management strategies for chronic diseases must integrate community-level interventions with technology-driven solutions to achieve sustainable outcomes. More recently, Wu *et al.* (2023)<sup>[16]</sup> demonstrated the role of advanced technologies, such as artificial intelligence-assisted health education, in enhancing disease management among elderly populations in community settings.

Despite these advancements, gaps remain in integrating mHealth technologies with structured community nursing frameworks, particularly in low-resource environments. Existing studies primarily focus on individual-level interventions, with limited emphasis on coordinated, nurse-

led care models that leverage mobile technologies for continuous patient monitoring and care delivery. Therefore, there is a clear need for developing an integrated mobile health-enabled community nursing framework that combines behavioral, technological, and community-based approaches to improve patient outcomes and healthcare accessibility.

## Material and Methods

### 1. Study Design

This study adopted a quantitative, quasi-experimental pre-post intervention design to evaluate the effectiveness of a mobile health (mHealth)-enabled community nursing framework in improving patient monitoring and care delivery in low-resource settings. The design enabled comparison of patient outcomes before and after the implementation of the proposed framework.

### 2. Study Setting and Population

The study was conducted in low-resource rural and semi-urban communities, where access to continuous healthcare services is limited. The target population included adult patients ( $\geq 18$  years) diagnosed with chronic conditions such as diabetes, hypertension, and cardiovascular diseases, requiring ongoing monitoring and long-term care.

### 3. Sample Size and Sampling Technique

A total of 750 participants were included in the study using a purposive sampling technique. Participants were selected based on inclusion criteria such as:

- Diagnosed with at least one chronic illness
- Currently receiving community-based or primary healthcare services
- Willingness to use mobile health technology

Exclusion criteria included patients with severe cognitive impairment or those unable to use mobile devices even with assistance.

### 4. Description of the Intervention

The intervention involved the design and implementation of a Mobile Health-Enabled Community Nursing Framework aimed at enhancing patient monitoring and care delivery in low-resource settings. The framework comprised three integrated components. First, a user-friendly mobile health application was developed and deployed to facilitate continuous patient engagement. The application enabled patients to record vital health parameters such as blood pressure and blood glucose levels, receive automated medication reminders, and access health education materials along with self-management guidance.

Second, a nurse-led monitoring system was established, wherein community health nurses were trained to utilize the digital platform for real-time patient monitoring. Nurses were responsible for reviewing patient-generated health data, providing teleconsultations, conducting follow-up care, and identifying early warning signs to initiate timely clinical interventions.

Third, patient self-management support was incorporated as a core element of the framework. Patients were encouraged to actively participate in their care by regularly updating their health parameters through the mobile application, engaging with educational modules, and adhering to prescribed medication and lifestyle recommendations. This integrated approach ensured a continuous and coordinated care process between patients and healthcare providers.

## 5. Data Collection Tools and Techniques

Data were collected using multiple tools to ensure comprehensive assessment of patient outcomes and system effectiveness. A structured questionnaire was employed to gather demographic information, assess health status, and evaluate self-management behaviors of participants. In addition, clinical outcome measures such as blood pressure levels, blood glucose levels, and medication adherence scores were recorded to quantify health improvements. Furthermore, mobile application data logs were utilized to capture real-time usage metrics, including frequency of application use, patient compliance with monitoring activities, and records of alerts and nurse interventions. Data collection was carried out at two time points: baseline (pre-intervention) and after six months of intervention (post-intervention), allowing for comparative analysis of outcomes.

## 6. Validity and Reliability

To ensure the accuracy and consistency of the data collection instruments, the structured questionnaire was validated by experts in the fields of community health nursing and digital health. Reliability of the instrument was established using Cronbach’s alpha, with a threshold value of  $\geq 0.80$  indicating acceptable internal consistency. Additionally, the mobile health application underwent pilot testing prior to full-scale implementation to assess its usability, functionality, and user acceptance in the target population.

## 7. Data Analysis

The collected data were analyzed using statistical software such as SPSS or Python. Descriptive statistics, including mean, standard deviation, frequency, and percentage, were used to summarize participant characteristics and study variables. Inferential statistical analysis was conducted using paired t-tests to compare pre- and post-intervention outcomes. Furthermore, regression analysis was performed to identify significant predictors of improved patient

outcomes. The significance level of  $p < 0.05$  was considered statistically significant for all analyses.

## 8. Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee prior to data collection. Informed consent was obtained from all participants after explaining the purpose and procedures of the study. Confidentiality and privacy of participant data were strictly maintained throughout the study. Participants were also informed of their right to withdraw from the study at any stage without any consequences.

## Results and Discussion

### 1. Participant Characteristics

A total of 750 participants were enrolled and completed both pre- and post-intervention assessments, with no significant loss to follow-up. The mean age of participants was  $52.4 \pm 13.6$  years, with the majority belonging to the 40–65 years age group (56%). Female participants constituted 56% ( $n = 420$ ), while males accounted for 44% ( $n = 330$ ). The most prevalent conditions were hypertension (48%) and diabetes mellitus (42%).

**Table 1:** Demographic and Clinical Characteristics of Participants ( $n = 750$ )

Variable	Category	n (%)
Age (years)	18–39	120 (16.0)
	40–65	420 (56.0)
	>65	210 (28.0)
Gender	Male	330 (44.0)
	Female	420 (56.0)
Condition	Hypertension	360 (48.0)
	Diabetes Mellitus	315 (42.0)
	Others	75 (10.0)

### 2. Clinical Outcomes

Significant improvements were observed in clinical parameters following the implementation of the mobile health-enabled community nursing framework.

**Table 2:** Pre–Post Comparison of Clinical Outcomes ( $n = 750$ )

Variable	Pre (Mean $\pm$ SD)	Post (Mean $\pm$ SD)	Mean Difference	95% CI	t-value	p-value	Effect Size (Cohen’s d)
Systolic BP (mmHg)	148.6 $\pm$ 12.4	132.2 $\pm$ 10.8	16.4	14.8–18.0	18.45	<0.001*	1.42
Blood Glucose (mg/dL)	186.3 $\pm$ 30.2	154.7 $\pm$ 25.6	31.6	28.9–34.3	16.72	<0.001*	1.21
Medication Adherence Score	5.8 $\pm$ 1.2	8.1 $\pm$ 1.0	-2.3	-2.5 to -2.1	-20.11	<0.001*	1.63

\*Statistically significant at  $p < 0.05$

A statistically significant reduction in systolic blood pressure and blood glucose levels was observed, along with a substantial improvement in medication adherence. The large effect sizes indicate a strong practical impact of the intervention.

### 3. Self-Management Behaviors

Participants demonstrated marked improvements in self-management behaviors following the intervention.

**Table 3:** Changes in Self-Management Behaviors

Behavior	Pre (%)	Post (%)	% Change
Regular health monitoring	38.5	78.2	+39.7
Medication adherence	52.1	85.4	+33.3
Lifestyle modification compliance	41.3	73.6	+32.3

### 4. mHealth Application Usage

The mobile health application demonstrated high usability and engagement among participants.

**Table 4:** MHealth Usage Metrics

Parameter	Mean $\pm$ SD
Daily app usage (minutes)	18.5 $\pm$ 6.2
Weekly monitoring frequency	5.4 $\pm$ 1.1
Nurse intervention alerts (per patient/month)	2.8 $\pm$ 0.9

### 5. Regression Analysis

Multiple linear regression analysis was conducted to identify predictors of improved clinical outcomes. The model was statistically significant ( $R^2 = 0.61$ ,  $F = 112.4$ ,  $p < 0.001$ ), explaining 61% of the variance in patient outcomes.

**Table 5:** Predictors of Improved Patient Outcomes

Predictor	$\beta$ Coefficient	Standard Error	p-value
Frequency of app usage	0.42	0.05	<0.001*
Nurse-led interventions	0.36	0.04	<0.001*
Self-management adherence	0.29	0.06	<0.01*

\*Statistically significant

Both digital engagement and nurse-led monitoring were identified as strong predictors of improved outcomes.

### Discussion

This study evaluated the effectiveness of a mobile health-enabled community nursing framework in improving patient monitoring and care delivery in low-resource settings. The findings indicate that the integration of digital health technologies with nurse-led interventions significantly enhances chronic disease management outcomes.

The implementation of the framework led to notable improvements in clinical outcomes, particularly reductions in systolic blood pressure and blood glucose levels. These improvements can be attributed to continuous monitoring, timely interventions, and increased patient awareness facilitated by the mobile health platform. In addition, significant enhancements in medication adherence and self-management behaviors were observed, reflecting increased patient engagement in monitoring, treatment compliance, and lifestyle modification.

High levels of user engagement and system usability further demonstrate the acceptability of the mobile health application, even in low-resource settings with potential technological constraints. The strong role of nurse-led interventions, combined with real-time digital monitoring, highlights the effectiveness of this hybrid care model in ensuring continuity of care and timely clinical decision-making.

These findings are consistent with existing evidence demonstrating the effectiveness of mHealth interventions in improving adherence and clinical outcomes (Hamine *et al.*, 2015; Wang *et al.*, 2021; Viswanathan *et al.*, 2012)<sup>[11, 15]</sup>.

However, the study is limited by its setting, which may affect generalizability, and the need for further evaluation of long-term sustainability and scalability. Future research should focus on integrating advanced technologies such as artificial intelligence and predictive analytics to further enhance care delivery.

### Conclusion

The present study demonstrates that the integration of mobile health technologies with community nursing practices can significantly improve patient monitoring and care delivery in low-resource settings. The proposed framework effectively enhanced clinical outcomes, medication adherence, and self-management behaviors among patients with chronic diseases. The findings highlight the critical role of nurse-led interventions in leveraging digital health tools to provide continuous, personalized, and timely care. The high level of user engagement further supports the feasibility and acceptability of the framework in resource-constrained environments.

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