



NEEDS ANALYSIS AND INITIAL DESIGN OF A MOBILE AND ARTIFICIAL INTELLIGENCE-BASED SELF-CARE APPLICATION FOR TYPE 2 DIABETES MELLITUS PATIENTS

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ABSTRACT

Patients with DM Type 2 often face challenges in consistently performing self-care, especially foot care, which can lead to serious complications such as diabetic foot ulcers. Knowledge of diabetes and health literacy are key factors affecting self-care practices. Mobile-based digital technology and Artificial Intelligence (AI) can support education, reminders, and continuous monitoring to improve diabetes management in primary care. This study aimed to analyze the needs of DM Type 2 patients in self-care and to design a preliminary prototype of a mobile application integrated with AI as a supportive self-care tool tailored to patients and healthcare providers. A mixed-method sequential explanatory design was employed. Purposive sampling was used to recruit 112 patients with Type 2 Diabetes Mellitus for the quantitative phase using the Diabetes Knowledge Questionnaire (DKQ-24), Summary of Diabetes Self-Care Activities (SDSCA), and eHealth Literacy Scale (eHEALS). Qualitative data were obtained through in-depth interviews with 5 patients and 3 healthcare providers. Integration of quantitative and qualitative findings guided the design of a preliminary mobile application prototype with Artificial Intelligence (AI) features. Most patients had sufficient diabetes knowledge (67.9%) but low self-care (79.5%) and health literacy (59.8%). Positive correlations were found between diabetes knowledge and self-care ($p = 0.383$; $p < 0.001$) and between health literacy and self-care ($p = 0.755$; $p < 0.001$). Patients understood basic DM management but often neglected foot care and expressed high interest in using a digital application with reminders, guidance, and AI-based personalized recommendations. The initial mobile AI-based application prototype is relevant, user-centered, and has the potential to improve self-care practices, particularly foot care, among DM Type 2 patients in primary healthcare.

Keywords: artificial intelligence; diabetes mellitus type 2; health literacy ; mobile application; self-care

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INTRODUCTION

Diabetes Mellitus (DM) is a non-communicable disease that has become a global health concern and is included in the Sustainable Development Goals (SDGs) 3 agenda, which aims to ensure healthy lives and promote well-being for all ages. Type 2 DM is a chronic condition with a growing prevalence over the years. According to the International Diabetes Federation (IDF), Indonesia ranked fifth globally with an estimated 19.5 million cases in 2021 (International Diabetes Federation, 2021). In 2025, IDF reported that 11.1% of the adult population (20–79 years) lived with diabetes (International Diabetes Federation, 2025). National health surveys also show an increase in DM prevalence in Indonesia from 5.7% in 2007 to 11.7% in 2023 (Badan Kebijakan Pembangunan Kesehatan, 2023). If effective clinical and behavioural interventions are not implemented, the prevalence is predicted to continue rising. Type 2 DM can lead to severe complications such as kidney failure, blindness, cardiovascular disease, stroke, and diabetic foot ulcers if not properly managed (Farmaki et al., 2020; Prabowo & Risdianto, 2023). Poor self-care, including diet regulation, physical activity, blood glucose monitoring, and medication adherence, is directly associated with higher complication risks and lower quality of life (Toar, Rooroh, & Pontoh, 2024). The development of digital technology, particularly mobile health applications integrated with Artificial Intelligence (AI), offers strategic opportunities to support DM self-care.

AI-enabled mobile applications can provide education, reminders, and personalised recommendations in real-time, bridging gaps in conventional healthcare services and supporting independent patient management (Viandarisa et al., 2021; Guan et al., 2023; Irnawan, Kadar, & Sjattar, 2021). However, studies in Indonesia indicate that current mHealth applications mainly use basic features such as SMS messages, educational videos, or manual reporting, with limited integration of AI or design based on local patient needs, digital literacy, and preferences (Firdaus et al., 2023; Retnoningrum, Masfuri, & Herawati, 2023; Wahyudi, Ode, & Rahman, 2019). This gap highlights the need for research to identify the self-care needs of Type 2 DM patients and develop adaptive, user-friendly, technology-based solutions. This study aims to analyse the needs of patients in self-care and to design an initial prototype of a mobile application integrated with AI tailored to patient requirements and healthcare provider input.

METHOD

A mixed-method sequential explanatory design was employed to assess the self-care needs of patients with Type 2 Diabetes Mellitus (DM) and to inform the application design. In the quantitative phase, a purposive sampling technique was used to recruit 112 patients with Type 2 DM who met the inclusion criteria (diagnosed with Type 2 DM, aged ≥ 18 years, and receiving care at primary healthcare facilities). Quantitative data were collected using the Diabetes Knowledge Questionnaire (DKQ-24), the Summary of Diabetes Self-Care Activities (SDSCA), and the eHealth Literacy Scale (eHEALS). Quantitative data were analysed using descriptive statistics to describe levels of diabetes knowledge, self-care, and health literacy, and Spearman's rank correlation test to examine the relationships between diabetes knowledge, health literacy, and self-care practices. In the qualitative phase, purposive sampling was also applied to select 5 patients and 3 healthcare providers who were considered information-rich and had direct experience in diabetes self-care and patient education. Qualitative data were collected through in-depth interviews and analysed using thematic analysis, which involved data transcription, coding, categorisation, and theme development. Integration of quantitative and qualitative findings was conducted at the interpretation stage, where qualitative results were used to explain and enrich the quantitative findings. This integration guided the development of a preliminary mobile application prototype with Artificial Intelligence (AI) features tailored to patient needs and preferences.

RESULT

Quantitative Data

The quantitative data were obtained from 112 patients with Type 2 Diabetes Mellitus who completed the *Diabetes Knowledge Questionnaire* (DKQ-24), *Summary of Diabetes Self-Care Activities* (SDSCA), and *eHealth Literacy Scale* (eHEALS). The analysis indicated that

Overview of Diabetes Knowledge, Self-Care, and Health Literacy

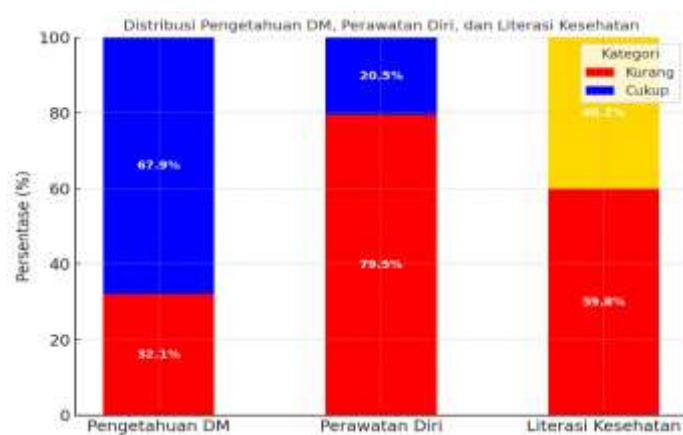


Figure 1. Frequency Distribution of Diabetes Knowledge, Self-Care, and Health Literacy

The results showed that the majority of respondents had adequate knowledge about DM (67.9%), yet self-care practices remained low, with 79.5% classified as inadequate. Meanwhile, health literacy was also relatively low, at 59.8%.

Relationship between Knowledge and Self-Care

Table 1.

Relationship between Knowledge and Self-Care					
Diabetes Knowledge	Poor self-care	Adequate self-care	N	Spearman's rho	Sig.(p)
Low	35	1	36	0.383	0.000
Sufficient	46	30	76		

Based on the analysis, there was a significant positive relationship between Diabetes Mellitus (DM) knowledge and patients' self-care. Among the 112 respondents, most patients with low DM knowledge (35 out of 36) also had poor self-care, whereas patients with adequate DM knowledge showed better self-care, with 30 out of 76 demonstrating sufficient self-care. Spearman's correlation analysis yielded a rho value of 0.383 with a significance of $p = 0.000$, indicating a moderate and statistically significant positive relationship.

Relationship Between Health Literacy and Self-Care

Table 2.

Relationship Between Health Literacy and Self-Care					
Health Literacy	Poor self-care	Adequate self-care	N	Spearman's rho	Sig.(p)
Low	67	0	67	0.755	0.000
Sufficient	14	31	45		

Based on the analysis, there was a strong and significant positive relationship between patients' health literacy and self-care among Diabetes Mellitus (DM) patients. Among the 112 respondents, all patients with low health literacy (67 individuals) also had poor self-care, whereas the majority of patients with adequate health literacy (31 out of 45) were able to perform self-care effectively. Spearman's correlation test yielded a rho value of 0.755 with a significance level of $p = 0.000$, indicating a very strong and statistically significant association. Hal ini menegaskan bahwa literasi kesehatan yang lebih baik secara langsung berkaitan dengan kemampuan pasien dalam menjalankan perawatan diri, sehingga peningkatan literasi kesehatan menjadi strategi penting untuk mendukung pengelolaan DM yang efektif. Penelitian sebelumnya juga mendukung temuan ini. Penelitian sebelumnya menyatakan adanya hubungan signifikan antara literasi kesehatan dengan manajemen perawatan diri pada pasien DM tipe 2 di RS PKU Muhammadiyah [2]. Selain itu, penelitian lain menemukan bahwa literasi kesehatan berhubungan positif dengan manajemen diri diabetes dan kontrol glikemik. Temuan ini menekankan pentingnya peningkatan literasi kesehatan sebagai strategi untuk meningkatkan perawatan diri pasien DM dan mencegah komplikasi lebih lanjut.[3]

Data Kualitatif

Qualitative analysis was conducted through in-depth interviews with patients with Type 2 Diabetes Mellitus (DM) and healthcare providers. The analysis identified several key themes related to self-care experiences, barriers to implementation, use of technology, expectations regarding the application, healthcare providers' perspectives, and perceptions of Artificial Intelligence (AI) utilization.

Tabel 3.

Qualitative Matrix Results

Theme	Subtheme	Main Findings	Illustrative Quotations
Self-Care Understanding and Practice	Knowledge and routines	Patients have a basic understanding of blood glucose control and medication adherence, but foot care is often neglected.	"I only check my feet occasionally, not every day." – Patient 1
Barriers to Self-Care	Lack of support	Daily activities, forgetting routines, insufficient knowledge, and limited	"Sometimes I forget because I'm busy." –

			family support hinder consistent self-care practices.	Patient 2
Technology Utilization	Experience and interest		Some patients have used simple applications, but none have used technology to support foot care management.	"If there is an application that reminds me, I would like it." – Patient 3
Application Expectations	Needed features		Patients expect practical features such as medication reminders, blood glucose monitoring, foot care guidance, and routine check-up notifications.	"I want an application that reminds me to check my feet." – Patient 4
Healthcare Providers' Perspective	Education and monitoring		Healthcare providers perceive digital applications as tools to enhance education, monitoring, and continuity of care, especially due to limited time for direct education.	"Nurses often have limited time to provide education." – Nurse 2
Perception of Artificial Intelligence (AI)	Understanding and expectations		Patients and healthcare providers believe AI can help deliver personalized recommendations, habit-based reminders, and continuous monitoring.	"If the application can remind patients automatically, it will really help." – Nurse 3

DISCUSSION

Quantitative Data

Relationship between Knowledge and Self-Care

Based on the analysis, there was a significant positive relationship between Diabetes Mellitus (DM) knowledge and patients' self-care. Among the 112 respondents, most patients with low DM knowledge (35 out of 36) also had poor self-care, whereas patients with adequate DM knowledge showed better self-care, with 30 out of 76 demonstrating sufficient self-care. Spearman's correlation analysis yielded a rho value of 0.383 with a significance of $p = 0.000$, indicating a moderate and statistically significant positive relationship. This finding suggests that the higher the patient's knowledge of DM, the better their ability to perform self-care, emphasizing the importance of education as a strategy to improve self-care quality among DM patients. This aligns with previous research indicating that patients with higher DM knowledge are more likely to engage in better self-care practices than those with lower knowledge (Azmiardi, 2020).

Relationship Between Health Literacy and Self-Care

Based on the analysis, there was a strong and significant positive relationship between patients' health literacy and self-care among Diabetes Mellitus (DM) patients. Among the 112 respondents, all patients with low health literacy (67 individuals) also had poor self-care, whereas the majority of patients with adequate health literacy (31 out of 45) were able to perform self-care effectively. Spearman's correlation test yielded a rho value of 0.755 with a significance level of $p = 0.000$, indicating a very strong and statistically significant association. This finding emphasizes that better health literacy is directly related to patients' ability to perform self-care, making the improvement of health literacy a crucial strategy to support effective DM management. Previous studies also support this finding, showing a significant relationship between health literacy and self-care management among patients with DM type 2 at RS PKU Muhammadiyah (Dewi & Rekawati, 2025). Furthermore, other research indicates that health literacy is positively associated with diabetes self-management and glycaemic control, highlighting the importance of enhancing health literacy as a strategy to improve self-care and prevent further complications in DM patients (Nugent, Fathima, & Smith, 2023).

Qualitative Data

Understanding and Practice of Self-Care in DM Type 2 Patient

The qualitative analysis revealed that patients with DM Type 2 generally understand the basic aspects of disease management, such as blood glucose monitoring and medication adherence. However, comprehensive self-care practices remain suboptimal, particularly foot care, which is

frequently neglected despite patients' awareness of its importance in preventing complications. These findings align with recent community surveys reporting that foot care practices are often less prioritized than medication adherence and dietary management among DM Type 2 patients ((Supramaniam, Beh, Junus, & Raman, 2024).

Barriers to Self-Care

Several barriers to self-care were identified, including daily busyness, forgetting care schedules, limited practical knowledge, and insufficient understanding of proper foot care. Social support also played a key role; patients receiving support from family and healthcare providers tended to adhere more consistently to self-care routines. These results are consistent with current literature emphasizing the importance of individual factors and social support in successful chronic disease self-management (Öcal, 2024). Utilisation of Technology in Self-Care Some patients have used simple digital applications, such as medication reminders, but none had employed technology to support foot care. Nevertheless, most patients expressed interest and readiness to use digital applications as self-care companions. This finding supports systematic reviews indicating that mobile health (mHealth) use can improve patient adherence and engagement in DM management, especially when applications are tailored to user needs and preferences (Indraswari, Yulia, & Hariyati, 2024; (Tang, Zhao, Li, et al., 2024).

Expectations for Mobile Application Feature

Patients expected practical and user-friendly application features, including medication reminders, blood glucose logging, dietary guidance, foot care instructions, and routine check-up notifications. This aligns with meta-analyses showing that interactive applications offering practical education and reminder features can enhance health literacy and self-care behaviours in DM Type 2 patients (Tang, Zhao, Li, et al., 2024).

Perception of Artificial Intelligence Integration

A novel aspect of this study is the positive perception of both patients and healthcare providers regarding the use of Artificial Intelligence (AI) in self-care applications. AI is seen as capable of providing personalised recommendations, habit-based reminders, and monitoring patients outside healthcare facility hours. Recent international studies demonstrate that integrating AI into diabetes management applications supports intervention personalization, improves adherence, and promotes earlier complication prevention (Begum et al., 2025; Islahati, Purwono, & Dewa, 2024).

Healthcare Providers' Perspective

Healthcare providers reported limited time and resources as challenges in delivering continuous self-care education, particularly regarding foot care. Therefore, mobile and AI-based applications could strengthen education, enhance focus on foot care, and support patient self-monitoring. Integrating these qualitative findings with quantitative data confirms that the preliminary design of a mobile AI-based self-care application is relevant, user-centered, and has the potential to improve DM Type 2 management outcomes.

Integration Analysis of Mixed Method (Quantitative–Qualitative)

This study employed a mixed-method approach using a sequential explanatory design, where quantitative results served as the basis for qualitative exploration. Data integration was performed by comparing, confirming, and enriching findings from both approaches to provide a comprehensive understanding of the self-care needs of DM Type 2 patients. Quantitative analysis indicated that most respondents had adequate DM knowledge, yet self-care practices remained low, particularly in areas such as foot care. These findings were reinforced by qualitative results showing that patients generally understood the importance of DM management but lacked consistent habits and practical skills in performing self-care, especially foot care. A significant positive correlation was found between knowledge and self-care ($\rho = 0.383$; $p < 0.001$) and a very strong correlation

between health literacy and self-care ($p = 0.755$; $p < 0.001$), aligning with qualitative findings that patients with better health literacy were more capable of applying self-care. In-depth interviews revealed that limited health literacy hindered patients' ability to translate medical information into daily practical actions. Additionally, qualitative data highlighted non-cognitive factors affecting low self-care, such as busy schedules, forgotten care routines, limited social support, and constrained time for education from healthcare providers. These factors were not fully captured in quantitative measurements but play a crucial role in explaining why self-care remained low despite relatively adequate patient knowledge. Integration of findings also revealed a gap between patient needs and conventional educational services. Quantitative findings of low health literacy and self-care were reinforced by patients' and healthcare providers' expectations for mobile and AI-based digital applications as self-care support solutions. Thus, the mixed-method approach provides a strong empirical basis that the design of a mobile AI-based self-care application should emphasize improving health literacy, establishing self-care habits, and providing accessible continuous support for patients. The results indicate that although most DM Type 2 patients possess sufficient knowledge about their disease, actual self-care implementation remains suboptimal. This suggests that knowledge alone is insufficient to drive behavioral change in self-care, particularly if not supported by adequate health literacy and sustained support systems. This aligns with prior findings showing that health literacy is a critical factor influencing patients' ability to manage themselves effectively, including diet, physical activity, and foot care management (Subiyanto et al., 2022).

The positive association between knowledge and self-care observed in this study supports health behavior theories, which suggest that knowledge is a prerequisite for developing healthy behaviors. However, the moderate strength of this relationship indicates the presence of mediating factors such as motivation, social support, and ease of access to practical information. Higher information comprehension was correlated with better self-care management among DM Type 2 patients in primary care settings (Djunarko et al., 2021). The most prominent finding was the strong relationship between health literacy and self-care, as health literacy enables patients not only to understand medical information but also to apply it in daily actions. Other quantitative studies similarly demonstrated a significant positive correlation between health literacy and patients' ability to perform overall self-care in DM, including diet, exercise, and other self-management practices (Riska et al., 2021). Qualitative findings provided additional context to the quantitative results, particularly regarding patients' low attention to foot care. While patients tended to prioritize blood glucose monitoring and medication adherence, foot care was often considered less urgent. Local studies also indicated a significant relationship between health literacy and foot care as part of self-care, emphasizing the need for greater understanding of complications such as diabetic foot ulcers (Subiyanto et al., 2022).

The use of digital technology emerges as a strategic opportunity to address this need. Systematic reviews and studies on mobile health (mHealth) indicate that mobile technology in DM Type 2 management can enhance self-care practices, including diet regulation, blood glucose monitoring reminders, and therapy adherence, particularly when applications are interactive and user-centered (Irawan et al., 2022). Healthcare providers' limited time and resources make continuous face-to-face education challenging. Mobile and AI-based digital technologies can facilitate personalized and continuous education, such as automated reminders, condition-specific self-care guidance, and support for self-monitoring outside healthcare facility hours, thereby increasing self-care effectiveness (Putri et al., 2023). Therefore, these findings reinforce that the preliminary design of a mobile AI-based self-care application is not only technologically innovative but also genuinely relevant and based on the real needs of DM Type 2 patients. This provides a strong foundation for the next stage of the research roadmap, which involves developing and piloting the application prototype. Consequently, this approach is projected to overcome barriers in traditional self-care implementation and enhance patient engagement in long-term health management.

CONCLUSION

This study provides a comprehensive needs analysis and initial design for a mobile and Artificial Intelligence (AI)-based self-care application tailored for Type 2 Diabetes Mellitus (DM) patients. The mixed-method sequential explanatory approach revealed that, although most patients possess adequate diabetes knowledge, their self-care practices—particularly foot care—remain suboptimal due to limited health literacy, non-cognitive barriers, and constrained support from healthcare providers. Qualitative findings highlighted patients' interest in using mobile applications with practical guidance, reminders, and AI-based personalized recommendations, while healthcare providers emphasized the potential of digital tools to supplement education and monitoring.

The integration of quantitative and qualitative data confirmed that a user-centered mobile AI-based application can address gaps in self-care by enhancing health literacy, facilitating habit formation, and providing continuous, accessible support. Therefore, the preliminary prototype is not only technologically feasible but also highly relevant to the real needs of DM Type 2 patients. These findings provide a solid foundation for the next stage of development, including prototyping and pilot testing, with the potential to improve adherence to self-care practices and prevent complications, especially diabetic foot ulcers, in primary healthcare settings.

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