



Millenium, 2(Edição Especial Nº23)



APLICAÇÕES MÓVEIS PARA O AUTOCUIDADO DOS PÉS NA DIABETES TIPO 2: SCOPING REVIEW
MOBILE APPLICATIONS FOR FOOT SELF-CARE IN TYPE 2 DIABETES: SCOPING REVIEW
APLICACIONES MÓVILES PARA EL AUTOCUIDADO DE PIES EN DIABETES TIPO 2: SCOPING REVIEW

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RECEIVED: 01st October, 2025

REVIEWED: 02nd April, 2026

ACCEPTED: 17th April, 2026

PUBLISHED: 05th June, 2026

DOI: <https://doi.org/10.29352/mill0223e.43437>

RESUMO

Introdução: A doença do pé relacionada com a diabetes compromete a qualidade de vida, eleva morbilidade, mortalidade e custos de saúde. As aplicações móveis surgem como estratégia promissora para apoiar o autocuidado dos pés na diabetes tipo 2, embora âmbito e características das ferramentas permaneçam pouco claros.

Objetivo: Mapear a extensão e natureza da literatura sobre aplicações móveis para o autocuidado dos pés em adultos com diabetes tipo 2, descrevendo conteúdo, funcionalidades e lacunas.

Métodos: Realizou-se revisão de escopo segundo metodologia do Joanna Briggs Institute e PRISMA-ScR. As pesquisas decorreram em PubMed, Scopus, Web of Science, CINAHL, PsycINFO e em literatura cinzenta. Foram incluídos estudos com adultos com diabetes tipo 2 e aplicações para o autocuidado dos pés. A extração de dados considerou características e funcionalidades das aplicações.

Resultados: Dos 7.360 registos identificados, dez estudos cumpriram os critérios, reportando dez aplicações. As funcionalidades mais comuns incluíram lembretes, automonitorização e conteúdos educativos. Nenhuma aplicação integrou completamente as principais funcionalidades tecnológicas identificadas como relevantes para apoiar o autocuidado dos pés. Estratégias de mudança comportamental foram raramente aplicadas, e privacidade e segurança frequentemente negligenciadas.

Conclusão: Os achados evidenciam a necessidade de aplicações mais abrangentes, baseadas em evidência e centradas no utilizador. Integração de mudança comportamental e proteção da privacidade são fundamentais para intervenções eficazes. Esta revisão orienta futuras investigações, desenvolvimento e avaliação de soluções móveis em saúde, apoiando o autocuidado em doenças crónicas.

Palavras-chave: pé diabético; saúde digital; aplicações móveis; autocuidado; diabetes Mellitus tipo 2

ABSTRACT

Introduction: Diabetes-related foot disease impairs quality of life, increases morbidity and mortality, and generates high healthcare costs. Mobile health applications represent a promising strategy to support foot self-care in people with type 2 diabetes, yet their scope and characteristics remain unclear.

Objective: To map the extent and nature of the literature on mobile applications for foot self-care in adults with type 2 diabetes, describing content, functionalities, and gaps.

Methods: A scoping review was conducted following the Joanna Briggs Institute methodology and reported according to PRISMA-ScR. Searches were carried out in PubMed, Scopus, Web of Science, CINAHL, PsycINFO, and grey literature. Eligible studies involved adults with type 2 diabetes and mobile applications for foot self-care. Data extraction considered app characteristics and functionalities.

Results: Of the 7,360 records identified, ten studies met the inclusion criteria, reporting on ten applications. Common features included reminders, self-monitoring, and educational content. No application fully integrated the main technological functionalities identified as relevant to supporting foot self-care. Behavior change techniques were seldom applied, and privacy/security aspects were frequently overlooked.

Conclusion: The findings reveal the need for more comprehensive, evidence-based, user-centered mobile health applications for foot self-care in type 2 diabetes. Strengthening the integration of behavior change strategies and ensuring privacy protection are critical for effective interventions. This review guides future research, development, and evaluation of mobile health solutions, supporting self-care in chronic diseases.

Keywords: diabetic foot; digital health; mobile applications; self care; diabetes Mellitus, type 2

RESUMEN

Introducción: La enfermedad del pie relacionada con la diabetes compromete la calidad de vida, incrementa morbilidad, mortalidad y costes sanitarios. Las aplicaciones móviles son una estrategia prometedoras para el autocuidado de los pies en diabetes tipo 2, aunque su alcance y características permanecen poco claros.

Objetivo: Mapear la extensión y naturaleza de la literatura sobre aplicaciones móviles para el autocuidado de los pies en adultos con diabetes tipo 2, describiendo contenido, funcionalidades y vacíos.

Métodos: Se realizó revisión de alcance según metodología del Joanna Briggs Institute y PRISMA-ScR. Búsquedas en PubMed, Scopus, Web of Science, CINAHL, PsycINFO y literatura gris. Se incluyeron estudios con adultos con diabetes tipo 2 y aplicaciones para el autocuidado de los pies. La extracción de datos consideró las características y funcionalidades de las aplicaciones.

Resultados: De los 7.360 registros identificados, diez estudios cumplieron los criterios de inclusión, informando sobre diez aplicaciones. Las funcionalidades comunes incluyeron recordatorios, automonitorización y contenidos educativos. Ninguna aplicación integró completamente las principales funcionalidades tecnológicas relevantes para apoyar el autocuidado de los pies. Las estrategias de cambio de comportamiento fueron raras y privacidad y seguridad desatendidas.

Conclusión: Los hallazgos revelan la necesidad de aplicaciones integrales, basadas en evidencia y centradas en el usuario. Integración de cambio de comportamiento y privacidad son esenciales para intervenciones eficaces. Esta revisión orienta investigaciones, desarrollo y evaluación de soluciones móviles en salud, apoyando el autocuidado en enfermedades crónicas.

Palabras clave: pie diabético; salud digital; aplicaciones móviles; autocuidado; diabetes Mellitus tipo 2

DOI: <https://doi.org/10.29352/mill0223e.43437>

INTRODUCTION

Diabetes-related foot disease (DFD) affects 40 to 60 million people worldwide, with a global prevalence of 6.4%, higher in individuals with type 2 diabetes mellitus (T2DM) than type 1 diabetes mellitus (International Diabetes Federation, 2021). These complications are devastating and potentially fatal, significantly reducing quality of life and imposing substantial financial burdens on healthcare systems (International Diabetes Federation, 2021), underscoring the need for preventive strategies.

Self-care is key to preventing DFD. The World Health Organization (WHO) defines it as individuals, families, and communities taking actions to maintain health, prevent diseases, and manage illnesses or disabilities, independently or with healthcare providers' guidance (WHO, 2022).

Healthcare professionals support self-care by helping patients develop knowledge, behaviors, and skills (Soares & Cunha, 2018; Kaufman & Mel, 2020; Lenzen et al., 2017). Effective support fosters autonomy and reduces healthcare service demand, positively impacting health systems (Lawn & Schoo, 2010; Lorig & Holman, 2003).

The lack of self-care support in DFD highlights the urgent need for targeted patient and family care. Effective DFD management requires multidisciplinary teams tailored to patient needs (Zamani et al., 2021). How can we optimize efforts and expand self-care support?

With the expansion of mobile telephony and the widespread use of smartphones, mobile health applications (apps) serve as valuable tools for healthcare professionals and patients, enhancing self-care support. mHealth refers to medical and public health practices supported by wireless mobile technologies (WHO, 2019).

Studies highlight mHealth's positive impact on self-care, improving knowledge, behavior, and self-efficacy (Hassan, 2017; Kilic & Karadağ, 2020; Moradi et al., 2019), potentially preventing comorbidities. A review found that apps effectively influence health behavior through user-friendly design, expert involvement, and accessibility features (Zhao, Freeman, & Li, 2016). These benefits highlight the potential of mHealth as a strategy to promote health equity by expanding access to care and fostering self-care training.

Despite its potential, mHealth must integrate scientific evidence, privacy safeguards, and data security to ensure effective public health interventions. Further research is needed to explore technologies that enhance knowledge and drive behavioral change (Schaper et al., 2024).

Evaluating foot self-care apps is essential, as little is known about their characteristics. Understanding their current state can guide future research. To our knowledge, no studies have addressed this topic. Therefore, this scoping review mapped the scope and nature of scientific literature on mobile apps for foot self-care in adults with T2DM, describing their content, functionalities, and gaps.

1. METHODS

A scoping review was conducted to explore mHealth applications for DFD self-care, an emerging field with limited evidence. This methodology maps evidence, identifies gaps, and suggests future research (Peters et al., 2021).

This review followed Joanna Briggs Institute (JBI) guidelines, comprising nine stages: definition and alignment of research objectives and questions; development and refinement of inclusion criteria based on the objectives; detailed procedures for evidence search, selection, extraction, and presentation; evidence identification; evidence selection; evidence extraction; evidence analysis; presentation of results; and synthesis of findings aligned with the review objectives, including conclusions and inferences (Peters et al., 2020).

1.1 Identification of the research question

This review addressed the following questions:

RQ1: What is the nature, extent, and scope of mobile health applications to support foot self-care in people with T2DM?

RQ2: What mobile apps are available for this purpose?

RQ3: What functionalities do these apps offer?

Studies were assessed using the PCC mnemonic strategy (Population, Concept, Context) (Peters et al., 2020). The population (P) included adults (≥ 18 years) with T2DM, the concept (C) focused on DFD self-care via mobile apps, and the context (C) was community settings.

1.2 Identification of relevant studies

Eligibility criteria included: (a) mobile applications supporting foot self-care in adults with T2DM, (b) studies of any design exploring user experience with these apps, (c) publications in English, Portuguese, or Spanish, and (d) full-text availability. The restriction to the selected languages was applied due to the authors' language proficiency, ensuring accurate screening and data extraction. Full-text articles were included to allow a comprehensive assessment of study characteristics and detailed extraction of information on application functionalities. Publications were excluded if they focused on other mHealth modalities, such as SMS (text messaging), patient monitoring devices, personal digital assistants, global positioning systems, or Bluetooth technologies; if they involved hospitalized participants; or if they were published before 2015.

1.3 Search Strategy

Published studies were searched in PubMed, Scopus, Web of Science, CINAHL, and PsycINFO. Gray literature was retrieved from the CAPES Theses and Dissertations Catalog and the Scientific Repository of Open Access of Portugal. Searches in these sources were conducted using terms aligned with the core concepts adopted in the bibliographic database searches. Retrieved records were subsequently screened according to the eligibility criteria applied in the review, including the exclusion of publications

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published before 2015. Searches were conducted between July and August 2025. The search followed three stages: (1) an exploratory search in JBI, Cochrane Library, MEDLINE, and CINAHL to refine search terms; (2) application of selected keywords and index terms; (3) manual screening of reference lists from included studies. The search strategy was developed with the assistance of two librarians specializing in health sciences and systematic reviews. The full search strategy for each database is presented in Table 1.

Table 1 - Full search strategies used in each database

Database	Search strategy
MEDLINE (via PubMed)	("Mobile Applications"[MeSH Terms] OR "Portable Electronic App"[All Fields] OR "Mobile Application"[All Fields] OR "Mobile Phone Application"[All Fields] OR "Mobile App"[All Fields] OR "Smartphone App"[All Fields] OR "Tablet App"[All Fields] OR "mHealth"[All Fields] OR "Telemedicine"[MeSH Terms] OR "Telehealth"[All Fields] OR "eHealth"[All Fields]) AND ("Patients"[MeSH Terms] OR "Patient"[All Fields] OR "Client"[All Fields] OR "Users"[All Fields] OR "Patient-Centered"[All Fields]) AND ("Self-Management"[MeSH Terms] OR "Self Management"[All Fields] OR "Self Care"[All Fields] OR "Self-Care"[MeSH Terms] OR "Self Monitoring"[All Fields] OR "Self-Monitoring"[All Fields] OR "Telemonitoring"[All Fields]) AND (("Foot"[All Fields] AND "Diabetic"[All Fields]) OR "Foot Ulcer"[All Fields] OR "Diabetic Foot"[MeSH Terms] OR "Diabetic Foot Syndrome"[All Fields])
SCOPUS	("Mobile Application" OR "Mobile App" OR "App Mobile" OR "Portable Electronic App" OR "Electronic App" OR "Portable Electronic Application" OR "mobile phone application*" OR "mobile health" OR "mHealth" OR "remote management" OR "app" OR "Telemedicine" OR "Telehealth" OR "eHealth") AND ("Patient" OR "Client" OR "patient-centered") AND ("Self-Management" OR "self management" OR "self-care" OR "selfcare" OR "self care" OR "telemonitoring" OR "telephone monitoring") AND (("Foot" AND "Diabetic") OR "Foot Ulcer" OR "diabetic foot" OR "Diabetic foot syndrome")
Web of Science	("Mobile Application" OR "Mobile App" OR "App Mobile" OR "Portable Electronic App" OR "Electronic App" OR "Portable Electronic Application" OR "mobile phone application*" OR "mobile health" OR "mHealth" OR "remote management" OR "app" OR "Telemedicine" OR "Telehealth" OR "eHealth") AND ("Patient" OR "Client" OR "patient-centered") AND ("Self-Management" OR "self management" OR "self-care" OR "selfcare" OR "self care" OR "telemonitoring" OR "telephone monitoring") AND (("Foot" AND "Diabetic") OR "Foot Ulcer" OR "diabetic foot" OR "Diabetic foot syndrome")
CINAHL	(MM "Mobile Applications") AND (MM "Patients") AND (MM "Self-Management") AND (MM "Diabetic Foot")
PsycInfo	("Mobile Application" OR "Mobile App" OR "App Mobile" OR "Portable Electronic App" OR "Electronic App" OR "Portable Electronic Application" OR "mobile phone application*" OR "mobile health" OR "mHealth" OR "remote management" OR "app" OR "Telemedicine" OR "Telehealth" OR "eHealth") AND ("Patient" OR "Client" OR "patient-centered") AND ("Self-Management" OR "self management" OR "self-care" OR "selfcare" OR "self care" OR "telemonitoring" OR "telephone monitoring") AND (("Foot" AND "Diabetic") OR "Foot Ulcer" OR "diabetic foot" OR "Diabetic foot syndrome")

1.4 Study selection

Search results were exported to EndNote for reference management and duplicate removal. Two authors independently applied the eligibility criteria to an initial sample of records, compared their decisions, and discussed divergences in order to refine the interpretation of the criteria before proceeding with the full screening process. Thereafter, two authors independently screened titles and abstracts and assessed the full texts of potentially eligible studies. Given the broad retrieval of records from gray literature sources, an initial high number of results was identified. To minimize the risk of excluding potentially relevant material, records retrieved from these sources were also screened according to the eligibility criteria established for the review, including the exclusion of publications published before 2015. Disagreements and uncertainties were resolved through discussion among the three authors.

1.5 Charting the data

Data extraction followed a structured form, collecting study characteristics (journal, document type, year, country, title, language, authors), methodology (objectives, methods, population/sample size, inclusion/exclusion criteria, data collection), and key findings (app impact, conclusions). App characteristics included name, languages, platform, developer affiliation, content, validation method, functionality, associated devices, data storage, security, and privacy. Study quality was not assessed, as this review aimed to map evidence rather than evaluate rigor (Peters et al., 2020).

1.6 Collating, summarizing, and reporting the results

A descriptive analysis of extracted data was conducted, guided by the research questions. From the included studies, we developed a table summarizing key data from the reviewed studies and another table listing existing mobile applications designed to support foot self-care in people with T2DM. Additionally, we created a table illustrating how these apps engage users and a final table outlining the most common associations between key aspects of app-based self-care interventions. The search process is depicted in the PRISMA-ScR flow diagram (Page et al., 2021). The review protocol was registered in the OSF repository (DOI: 10.17605/OSF.IO/4JU8X).

2. RESULTS

2.1 General characterization of the included studies

Figure 1 (PRISMA-ScR flowchart) illustrates the study selection process. The search identified 7,360 potentially relevant studies, including 412 from databases and 6,948 from gray literature. After screening titles and abstracts, 7,170 studies were excluded.

DOI: <https://doi.org/10.29352/mill0223e.43437>

Additionally, two studies were identified through reference screening. In total, ten studies met the eligibility criteria, comprising nine journal articles and one master's thesis. Tables 2 and 3 present a complete list and characteristics of the included studies.

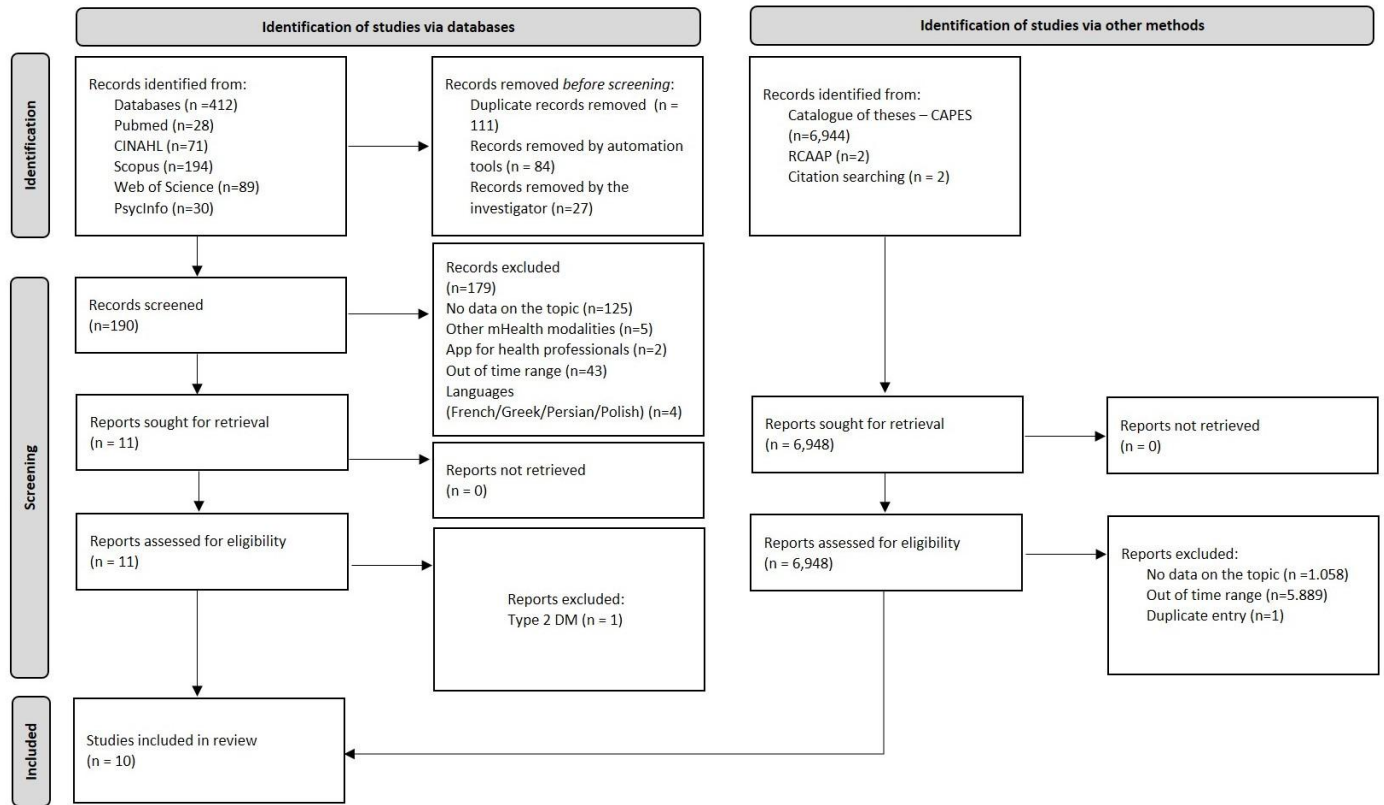


Figure 1 - Process of identification and inclusion of studies - PRISMA-ScR flowchart

Table 2 - Studies included in the scoping review according to authors, document type, title, source, origin and year of publication

Authors	Document Type	Study title	Source	Country	Year
Fraiwan et al. (2017)	Original Article	Diabetic foot ulcer mobile detection system using smartphone thermal camera: a feasibility study	Biomedical Engineering Online	United Arab Emirates	2017
Scarcella (2017)	Master's dissertation	Elaboration and development of a mobile application for self-care and self-monitoring of diabetic foot.	Universidade Federal de Minas Gerais; CAPES Theses and Dissertations Catalog	Brazil	2017
Ogrin et al. (2018)	Original Article	Co-design of an evidence-based health education diabetes foot app to prevent serious foot complications: a feasibility study	Practical Diabetes	Australia	2018
Kilic and Karadağ (2020)	Original Article	Developing and evaluating a mobile foot care application for persons with diabetes mellitus: a randomized pilot study	Wound Management & Prevention	Turkey	2020
Oe et al. (2021)	Original Article	Prevention of diabetic foot ulcers using a smartphone and mobile thermography: a case study	Journal of Wound Care	Japan	2021
Dincer and Bahçecik (2021)	Original Article	The effect of a mobile application in the foot care of individuals with type 2 diabetes: A randomised controlled study	Health Education Journal	Turkey	2021
Moulaei et al. (2021)	Original Article	A smart wearable device for monitoring and self-management of diabetic foot: A proof of concept study	International Journal of Medical Informatics	Irã	2021
Haycocks et al. (2022)	Original Article	Implementation of a novel mHealth application for the management of people with diabetes and recently healed foot ulceration: A feasibility study	Digital Health	United Kingdom	2022
Marques (2023)	Original Article	Mobile Application for Adhering to Diabetic Foot Self-care: Randomized Controlled Clinical Trial	Computers, informatics, nursing: CIN	Brazil	2023
Ploderer et al. (2018)	Original Article	Promoting Self-Care of Diabetic Foot Ulcers Through a Mobile Phone App: User-Centered Design and Evaluation	JMIR Diabetes	Australia	2018

DOI: <https://doi.org/10.29352/mill0223e.43437>

Table 3 - Studies included in the scoping review according to methodology, participants, and results

Authors	Methodology	Participants	Results
Fraivan et al. (2017)	Feasibility study	The system was tested under simulated conditions.	The proposed system successfully identified areas with temperature elevation, which may help in the prediction of ulcers. Thus, it allows self-assessment.
Scarcella (2017)	Methodological and longitudinal study	11 adults	The app supported foot self-examination, helped identify risky behaviors, and provided guidance on foot self-care.
Ogrin et al. (2018)	Methodological study	35 individuals at risk of amputation (mean age 66.9)	The results indicated that an app of this nature was viable and acceptable and that it improves the attitude of self-care.
Kilic and Karadağ (2020)	Randomized controlled trial	44 patients in the experimental group and 44 in the control group (88 in total)	The results pointed out that the use of the app increased knowledge, helped participants to choose appropriate shoes, and reduced the incidence of cracked feet.
Oe et al. (2021)	Case study	02 patients with T2DM, with diabetic neuropathy and callus	The technology may support daily foot assessment at home and help patients understand the need for self-management to prevent diabetic foot ulcers.
Dincer and Bahçecik (2021)	Randomized controlled trial	65 individuals in the experimental group and 65 in the control group	The result showed that an app supported by an animated video increased the level of knowledge, self-efficacy, and foot care behaviors.
Moulaei et al. (2021)	Proof of concept study	04 individuals with diabetes and 01 without diabetes	Smart footwear and a mobile app were developed to monitor foot health. The app tracks pressure, temperature, and humidity, issuing alarms if parameters exceed defined thresholds, enabling real-time self-management to prevent foot ulcers.
Haycocks et al. (2022)	Feasibility study	15 adults	The app enables remote monitoring and proactive care. The average ulcer-free period reported (273.0 days) exceeded previous findings. Results suggest that the app requires only a modest reduction in recurrence compared to the standard of care to be a cost-effective strategy for preventing diabetic foot ulcers.
Marques (2023)	Randomized controlled trial	80 adults (40 in the control group and 40 in the experimental group)	The use of the app had a statistically significant effect on the frequency of daily foot assessment, adherence to foot self-care and knowledge related to diabetic foot prevention.
Ploderer et al. (2018)	Prospective mixed-methods cohort study	11 participants with diabetes-related foot ulcers	Most participants found app valuable for self-care, particularly for tracking ulcer healing through photos and graphs. They saw potential in sharing data with healthcare professionals who do not typically assess the ulcer during consultations. However, usage declined when ulcers showed no progress over time.

2.2 General characterization of mobile applications

The evaluation of eligible studies identified ten apps supporting foot self-care for DFD (Table 4). Most were developed for Android (n=5), while two were hybrid, compatible with both Android and iOS.

Table 4 - Mobile apps to support foot self-care in people with type 2 diabetes

	Application	Developer
1	MyFootCare	Queensland University of Technology
2	Application 1*	University of Tokyo
3	Application 2**	Abu Dhabi University
4	Application 3***	Iran University of Medical Sciences
5	Mobile Diabetic Foot Care (M-DFCE)	Istanbul Medeniyet University and Istanbul Sabahattin Zaim University
6	PedCare	State University of Ceará and Department of Teleinformatics Engineering (DETI), Federal University of Ceará (UFC)
7	PéDiabético[Diabetic foot]	Federal University of Minas Gerais
8	m-DAKBAS	Sanko University
9	Healthy Feet	RMIT University
10	INTELLIN®	Gendius Ltd, Macclesfield, UK

*Application 1 corresponds to the unnamed self-monitoring device using mobile thermography described by Oe et al. (2021).

**Application 2 corresponds to the unnamed app with a self-monitoring tool for acquiring thermal images described by Fraivan et al. (2017).

***Application 3 corresponds to the unnamed app and smart footwear system designed to monitor pressure, humidity, and temperature described by Moulaei et al. (2021).

The availability of these apps was checked post hoc in the Apple App Store and Google Play Store, based on application names and platform information reported in the included studies. This verification was conducted in August 2025. This step was

DOI: <https://doi.org/10.29352/mill0223e.43437>

undertaken during data extraction to verify current app availability and was not part of the formal search strategy. Three studies lacked app names, preventing verification (Fraiwan et al., 2017; Moulaei, Malek & Sheikhtaheri, 2021; Oe et al., 2021). Among those identified, only one (Marques et al., 2023) was freely available in the Google Play Store. None of the others were found in either store.

2.3 Foot self-care content and functionalities of evaluated apps

The self-care content and user engagement strategies of the evaluated applications were analyzed through their functionalities (Table 5). The most frequently identified features included self-monitoring of signs and symptoms (n=7) and reminder notifications (n=6), followed by educational resources and foot care guidance.

Table 5 - How apps engage users

Functionalities ^a	Number of applications n (%)
Self-monitoring of signs and symptoms	7 (70%)
Reminder notifications	6 (60%)
Delivery of educational information	5 (50%)
Guidelines for self-care	4 (40%)
Communication with the health team (remote monitoring)	3 (30%)
Goal setting	1 (10%)
Analysis of ulcer size	1 (10%)
Wellness diary	1 (10%)
Ulcer image gallery	1 (10%)
Video with exercises to improve circulation of the lower limbs	1 (10%)
Publicity of events and useful addresses	1 (10%)
Risk assessment	1 (10%)
Data entry during foot observation	2 (20%)
Blood glucose record	2 (20%)
Knowledge quiz on foot care	1 (10%)
Foot photo sharing	1 (10%)
Google search engine within the app	1 (10%)
Save contacts (possibility to call or send text messages within the app)	1 (10%)

^aThese are not mutually exclusive features. Apps engage users in different ways.

The evaluated apps included various notification features. MyFootCare (Ploderer et al., 2018) sent reminders for dressing changes and ulcer photography, while m-DAKBAS (Kilic & Karadağ, 2020) provided diabetes-related messages. MyFootCare, PedCare (Marques et al., 2023), and Healthy Feet (Ogrin et al., 2018) reminded users to schedule healthcare appointments. PedCare and Healthy Feet also issued daily foot care alerts, and M-DFCE (Dincer & Bahcecik, 2021) provided usage notifications. 'Application 3' (Moulaei, Malek & Sheikhtaheri, 2021) monitored pressure, temperature, and humidity, alerting users when values exceeded predefined limits. These notifications aimed to encourage adherence to recommended care routines.

Self-monitoring is essential for foot self-care, allowing individuals to track DFD signs and complications. Seven apps included this feature through photographic ulcer size recording, thermographic imaging, or manual foot observation entry. These apps were MyFootCare, 'Application 1' (Oe et al., 2021), 'Application 2' (Fraiwan et al., 2017), 'Application 3', Pé Diabético [Diabetic foot] (Scarcella, 2017), INTELLIN® (Haycocks et al., 2022), and m-DAKBAS.

The Pé Diabético [Diabetic Foot] app includes an evaluation guide for assessing DFD risk or trauma, incorporating key variables for self-examination. The mechanical variables include dry skin, cracks, abnormal edema, mycoses, and nail involvement. The vascular variables consist of foot hair loss, changes in foot color, claudication, and pain in the lower limbs at rest. Finally, the neuropathic variables encompass callosities, blisters, tingling sensations, wounds, deformities, pain, and a history of amputation.

To help users recognize risky behaviors that may lead to foot trauma, the Pé Diabético app assessed the following factors: foot mobility, inappropriate footwear use, footwear habits, nail trimming, foot hydration, and wearing socks. As users identified risky behaviors, the app provided personalized recommendations at the end of the assessment.

One of the most common functionalities identified was the provision of foot self-care guidelines, as seen in M-DFCE, Pé Diabético, m-DAKBAS, and Healthy Feet. These guidelines included daily foot self-care recommendations, particularly self-examination of the feet, proper foot hygiene, the use of appropriate socks and footwear, and nail care.

Education is a key self-care resource, yet only five apps included DFD-related educational content. Their approaches varied, covering diabetes-DFD relationships, condition definition, risk factors, prevention, and foot ulcer risk levels. While most provided text-based materials, M-DFCE used animated videos, M-DAKBAS offered interactive quizzes for knowledge assessment, and Healthy Feet included links to external resources.

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Within the educational context, the Healthy Feet app also covered the topic of first aid, highlighting urgent foot conditions requiring immediate action and encouraging users to seek medical care. This section also includes the telephone number of a nurse for emergencies.

None of the evaluated apps included content on emotional or psychological aspects like depression or anxiety, except MyFootCare, which allowed users to log well-being via emojis or diary entries. No apps provided peer or family support features, though m-DAKBAS incorporated motivational content.

Only MyFootCare included goal setting, allowing users to visualize personal goals through images that could be updated. For instance, a user recovering from a foot injury might insert an image of playing with grandchildren to stay motivated.

Three applications (m-DAKBAS, Application 3, and Healthy Feet) included feedback functionality, enabling communication with the health team via SMS, calls, or a management panel accessed by professionals. This allowed timely intervention in response to negative conditions reported by users.

Table 6 - Common associations of application self-care aspects

Associations of aspects of self-care	Number of features	Total number of apps used in combination (n)
Self-monitoring	1	2
Recommendations for self-care + Notifications/Reminders	2	1
Educational content + Self-care recommendations + Notifications/Reminders	3	1
Educational content + Self-monitoring + Recommendations for self-care	3	1
Self-monitoring + Self-care recommendations + Notifications/Reminders	3	1
Educational content + Self-monitoring + feedback	3	1
Educational content + Self-monitoring + feedback + Notifications/Reminders	4	1
Educational content + Self-care recommendations + feedback + Notifications/Reminders	4	1
Goal setting + Self-monitoring + Mention of emotional aspects + Notifications/Reminders	4	1

As shown in Table 6, two applications ('Application 1' and 'Application 2') focused solely on self-monitoring, while three (m-DAKBAS, Healthy Feet, and MyFootCare) integrated four features. The most common combinations included educational content with self-care recommendations, educational content with reminders, and self-care guidance with reminders. No application fully incorporated the main technological functionalities identified as relevant to supporting foot self-care.

2.4 User engagement in the development and scientific validation of applications

The identified applications targeted different groups of individuals: those with diabetic foot ulcers (n=2; MyFootCare and INTELLIN®), those with diabetes without foot injuries (n=5; M-DFCE, m-DAKBAS, Pé Diabético, 'Application 2', and 'Application 3'), those at risk of foot complications (n=2; PedCare and Healthy Feet), and individuals with T2DM at risk of foot complications (n=1; Application 1). Regarding user involvement in the application design process, five studies (Haycocks et al., 2022; Marques et al., 2023; Ogrin et al., 2018; Ploderer et al., 2018; Scarcella, 2017) reported the inclusion of participants during development to enhance usability and ensure relevance to end users.

Regarding scientific content validation, only three studies provided evidence of application validation by experts. More specifically, the content of the PedCare, M-DFCE, and m-DAKBAS applications was evaluated by nurses. Additionally, a professor specializing in endocrinology contributed to the validation of M-DFCE and m-DAKBAS, while a physician specializing in hyperbaric medicine assessed the m-DAKBAS application.

2.5 Data security and privacy

Privacy policies and data security were mentioned in four studies (40%). Three applications (M-DFCE, Pé Diabético [Diabetic foot], and m-DAKBAS) required user login and password authentication to ensure privacy and data security.

Application 2 allowed security features to be added at any time and relied on Android's device-level encryption. It operated offline, preventing data sharing and preserving user privacy.

The studies did not specify whether privacy policies were accessible before downloading or if user data was shared with third parties.

2.6 User satisfaction and acceptance

Six studies (60%) assessed perceived usefulness, ease of use, and user satisfaction. The most common data collection methods included interviews and focus groups (MyFootCare, PedCare, Healthy Feet); a Likert-scale questionnaire (Pé Diabético [Diabetic foot], INTELLIN®); and a mixed-methods survey (m-DAKBAS).

Results indicated that users found the applications useful (MyFootCare, PedCare), easy to use (PedCare, INTELLIN®), viable and acceptable (Healthy Feet), and satisfactory (Pé Diabético [Diabetic foot], m-DAKBAS). Notably, 80% of m-DAKBAS users wished to continue using the tool post-study.

DOI: <https://doi.org/10.29352/mill0223e.43437>

2.7 Effects of mobile applications for foot self-care in people with type 2 diabetes mellitus

Three studies evaluated the impact of mobile apps on health behaviors, including knowledge, self-efficacy, and self-care (Table 3). M-DFCE improved knowledge, self-efficacy, and foot self-care in pre- and post-study assessments. PedCare significantly increased daily foot examinations, adherence to self-care, and knowledge about DFD prevention. m-DAKBAS was more effective in enhancing knowledge through technological resources.

2.8 Additional aspects

Among the evaluated applications, m-DAKBAS is the only one that stores additional medical information, including fasting and postprandial blood glucose levels. Meanwhile, MyFootCare records wound progression and enables monitoring of the healing process through graphical representation.

Among the ten applications analyzed, three were developed in English (MyFootCare, Healthy Feet, and INTELLIN®), two in Turkish (M-DFCE and m-DAKBAS), and two in Portuguese (PedCare and Pé Diabético). Meanwhile, three applications did not specify their language.

Three applications (Application 1, Application 2, and Application 3) explored the possibility of integration with external devices. Specifically, Application 1, and Application 2 were designed to be used with a mobile thermograph, allowing the examination of the extremities for early detection of foot ulcers. Additionally, Application 3 supports integration with pressure sensors, temperature sensors, and humidity sensors, enabling real-time monitoring of key foot health parameters.

Our findings indicate that the most frequently incorporated behavior change techniques were self-monitoring and knowledge acquisition. However, none of the studies reported the inclusion of demonstration, instructional guidance, or conditioning features for specific behaviors.

3. DISCUSSION

This scoping review mapped the literature on mHealth apps for foot self-care in individuals with T2DM, analyzing their functionalities and content. A total of ten mHealth apps were identified in this review. While these findings indicate that mHealth solutions for foot self-care in T2DM have been developed, this remains a growing field with room for further research and innovation. Development of these apps has increased since 2017, highlighting their potential for expansion.

Despite variations, the apps shared similar functionalities. None fully integrated the main technological functionalities described in the literature as relevant for supporting foot self-care, such as personalized education, reminders, self-monitoring, and communication with healthcare professionals, highlighting opportunities for improvement (Méndez et al., 2025). More broadly, a systematic review indicates that mHealth apps are more effective when incorporating comprehensive, evidence-based diabetes self-care functions (Adu et al., 2018).

The American Diabetes Association (ADA) highlights social support, clinical sign monitoring, feedback, and education as key to diabetes care (ADA, 2021), though evidence from randomized clinical trials (RCTs) remains limited. The guidelines also recommend integrating online coaching with digital health technologies, as studies suggest it can be as effective as face-to-face approaches (Bus et al., 2018). However, none of the reviewed apps incorporated all these features or online coaching. Developers may consider integrating these recommendations, and future RCTs are needed to further assess these approaches.

Integrating an educational component into the management of people with T2DM is a fundamental aspect widely endorsed by clinical guidelines (ADA, 2021; Schaper et al., 2024). Interestingly, this review found that only five applications incorporated educational content. The underrepresentation of structured and personalized educational resources may be partially attributed to the challenges associated with designing and implementing comprehensive education modules. Additionally, there is a lack of research exploring optimal strategies for leveraging user data to personalize educational content, which may further contribute to this gap. This is particularly relevant in the context of health literacy, as educational resources that are not adapted to users' literacy levels may limit comprehension, engagement, and effective self-care support (Adu et al., 2018).

Our review identified studies reporting positive findings for outcomes such as knowledge about DFD, self-care behaviors, and self-efficacy, pointing to the potential of mHealth apps as supportive tools for foot self-care in individuals with T2DM. However, this finding contrasts with the results of a systematic review (El-Gayar, Ofori & Nawar, 2021) that evaluated the evidence supporting the impact of education on foot care in diabetes management regarding these same variables. That review concluded that the available evidence is not strong enough to assert that educating individuals with diabetes about foot care is an effective strategy to improve self-care behaviors, knowledge, or self-efficacy. These discrepancies may be attributed to differences in methodological quality. The systematic review assessed the rigor of the included studies and found that most exhibited low quality, with high attrition rates, a high risk of bias, and a lack of validated outcome measures, which may have compromised the strength of its conclusions.

Behavioral change techniques were underutilized in the reviewed apps. No studies have assessed their effectiveness in foot self-care, though a meta-analysis (El-Gayar, Ofori & Nawar, 2021) in diabetes suggests mHealth interventions incorporating these techniques yield positive outcomes.

DOI: <https://doi.org/10.29352/mill0223e.43437>

Foot health care in diabetes is fundamentally behavioral and requires strong self-care commitment, making behavior change techniques essential. Studies highlight the effectiveness of interventions integrating behavioral techniques (James et al., 2020; Ofori & El-Gayar, 2021; Webb et al., 2010; Yang & Van Stee, 2019). Identifying the most effective techniques is essential for sustained behavioral change. This review found monitoring and knowledge acquisition as the most applied techniques, while prior studies (Amalindah, Winarto & Rahmi, 2020; Liu, Xie & Or, 2020; Nelson et al., 2017; Van Rhoon et al., 2020) associate reductions in glycated hemoglobin with self-monitoring, social support, personalized feedback, mental resource conservation, patient-professional communication, and action planning.

We identified five applications that involved participants throughout their development and six studies that evaluated end-user satisfaction, suggesting that most developers were concerned with ensuring the tool's relevance to the target audience. Researchers emphasize the importance of implementation science in the development and evaluation of mHealth technologies (Dang et al., 2021; Ryll, 2021; Schneider, Hill & Blandford, 2016). Notably, there is a critical need to develop applications that are responsive to the real needs of patients. To achieve this, it is essential to consider the cost of app development and explore the potential for collaborative partnerships with commercial institutions and other research groups. Such collaborations could optimize time and investments, ultimately contributing to the creation of more effective and sustainable digital health solutions. We also emphasize that user-centered design is a key approach to enhancing the acceptability and dissemination of mHealth initiatives by fostering a deeper understanding of end-user needs and preferences among stakeholders involved in the development process (Bevan Jones et al., 2020; Dang et al., 2021; Harte et al., 2017; Moore et al., 2019; Vandekerckhove et al., 2020). In our review, two studies (Dincer & Bahcecik, 2021; Ogrin et al., 2018) adopted this approach, and in both cases, participants confirmed that the app was viable and acceptable, reinforcing the idea that user-centered design enhances acceptance. Therefore, the findings of this review highlight the need for continued development of mHealth technologies that prioritize the user perspective to improve engagement and effectiveness. Such user-centered considerations are especially important for older adults, who may experience visual, motor, or digital literacy barriers that affect accessibility and usability and should therefore be considered in app design and evaluation (Harte et al., 2017; Zhao, Freeman, & Li, 2016).

Regarding the scientific evaluation of content, our findings indicate that most evaluated apps did not provide information on scientific validation, highlighting an opportunity for further research and development in this area. Studies (Bautista, Zhang & Gwizdka, 2021; Song, Zhang & Yu, 2021) emphasize the importance of rigorous evaluation of digital health content to ensure that users receive accurate and evidence-based guidance. Additionally, IDF Europe (Rose et al., 2019) recommends that application developers establish and consult a scientific advisory committee. Beyond content validation, the involvement of healthcare professionals in the development process may also strengthen the clinical relevance, clarity, and practical applicability of app-based self-care support (Rose et al., 2019; Vandekerckhove et al., 2020). Therefore, incorporating expert evaluation of app content in alignment with medical guidelines and current scientific evidence on foot health could contribute to higher-quality information and enhanced DFD management, ultimately supporting safer and more effective self-care strategies.

Our review found that more than half of the included studies did not address data privacy and security policies, a critical challenge in mHealth app design. Concerns about privacy and security are key factors influencing trust in digital health technologies (Hogan et al., 2021; Jokinen, Stolt & Suhonen, 2021), yet studies indicate that security considerations are often overlooked during development (Adu et al., 2018). Common challenges include insufficient security recommendations, lack of developer expertise, and limited stakeholder involvement (Aljedaani & Babar, 2021). Addressing these issues through robust strategies and adherence to evidence-based security guidelines is essential to prevent potential risks.

To our knowledge, this is the first scoping review to examine mHealth apps for foot self-care in T2DM. The study followed a registered protocol with defined research questions. However, some limitations should be acknowledged. Despite rigorous adherence to scoping review methodology, relevant studies may have been unintentionally excluded. Additionally, methodological quality was not formally assessed, as scoping reviews focus on mapping evidence rather than evaluating study rigor. Finally, restricting the review to studies in English, Portuguese, and Spanish may have led to the omission of relevant publications. As technology adoption is influenced by cultural and social factors, some aspects of this review may have been overestimated, underestimated, or omitted.

CONCLUSION

Given the global burden of DFD and the potential of mHealth applications to support foot self-care in T2DM, assessing existing apps is fundamental due to the limited comprehensive information in this field.

In the past eight years, mHealth applications have increasingly emerged, as shown in the ten studies analyzed. These tools primarily offer reminders, self-monitoring, and educational content, but could incorporate broader functionalities such as social support, online coaching, and personalized education. Developers are encouraged to adopt a user-centered approach to ensure feasibility, acceptance, and effective healthcare integration.

Although still emerging, mHealth for DFD requires understanding challenges and opportunities to advance effective solutions. This review informs stakeholders of current characteristics, limitations, and strategies for future development.

DOI: <https://doi.org/10.29352/mill0223e.43437>

Further research should reassess academic and commercial applications to keep pace with mHealth advancements and identify necessary improvements. Additionally, we suggest an in-depth analysis of the health literacy demands embedded in these applications, as this is a key factor in addressing the diverse needs of the target audience.

AUTHORS' CONTRIBUTION

Conceptualization, G.L., M.J.L. and M.R.S.; data curation, G.L., M.J.L. and M.R.S.; formal analysis, G.L., M.J.L. and M.R.S.; investigation, G.L., M.J.L. and M.R.S.; methodology, G.L., M.J.L. and M.R.S.; project administration, G.L., M.J.L. and M.R.S.; resources, G.L., M.J.L. and M.R.S.; software, G.L., M.J.L. and M.R.S.; supervision, G.L., M.J.L. and M.R.S.; validation, G.L., M.J.L. and M.R.S.; visualization, G.L., M.J.L. and M.R.S.; writing- original draft, G.L.; writing – review & editing, G.L., M.J.L. and M.R.S.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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