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PAPER

# Digital Health Record Systems or Applications in the Management of Type 2 Diabetes: A Literature Review

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**ABSTRACT**

This literature review examines the integration of digital health record systems in the management of diabetes mellitus (DM), particularly type 2 diabetes, and highlights the urgent need for improved patient access to health information through technology. The use of information technology (IT) in the management of diabetes has shown remarkable results, such as increased medication adherence (12.8%–39%), lower HbA1c (0.49%–8%) levels, and lower blood pressure (47.2%–30.8%) levels. It also explores the benefits of mobile health (mHealth) applications, electronic health records (EHR), and personal health records (PHR) in improving self-management and healthcare support via social networks. It emphasizes the need for regular monitoring and communication facilitated by robust IT solutions that enable patients to access and share their health data, ensure effective communication, and support health monitoring. Unlike other reviews, we focus exclusively on proposals that facilitate interaction with medical records for automatic access to patient data. Our main contribution focuses on identifying critical needs to improve diabetes management through technology.

**KEYWORDS**

diabetes, mHealth, personal health record (PHR), electronic health records (EHR), medical records, digital record, social medical network

## 1 INTRODUCTION

Diabetes mellitus (DM) is a chronic, non-communicable metabolic disease characterized by elevated blood glucose levels. The most common form is type 2 diabetes (T2DM), which occurs when the body becomes resistant to insulin or no longer produces enough insulin [1]. With over 1.6 million deaths in 2021, diabetes is one of the leading causes of death worldwide, especially among older adults [2]. In 2021,

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10.5% (537 million) of adults aged 20–79 had diabetes, and it is predicted that this number could rise to 643 million by 2030 and 783 million by 2045 [3].

Technology significantly improves patient care, self-management, and monitoring in the context of diabetes, for example, the mobile application designed by authors of [4, 5]. With information technology (IT) medication adherence improved from 12.8% to 39%, blood glucose self-monitoring increased from 10.3% to 39%, HbA1c decreased from 0.49–8% [6, 7], blood pressure decreased from 47.2% to 30.8% [8]. mHealth refers to healthcare practices supported by mobile technologies, such as smartphones and wearable devices [9]. These tools facilitate the collection, storage, and retrieval of health data and enable real-time interactions that support informed health decisions [5, 10]. This approach can lead to sustainable care, cost reduction, and improved medical quality and quality of life [11]. Electronic health records (EHR) and personal health records (PHR) allow healthcare providers to effectively access and manage patient data. EHRs collect longitudinal data during healthcare [12], while PHRs store and manage the health data of individuals or family members [13].

This paper reviews the literature on digital health systems and applications for diabetes and highlights the different terminology used in this area. The literature review highlights different concepts, features, factors, and technologies related to diabetes management. This is important to answer our study questions: What functions should systems or applications for diabetes management that interface with PRH or EHR perform? What role does social support play in the success of digital health interventions for diabetes?

The paper is organized as follows: Section 2 discusses the literature review and its findings; Section 3 describes related terms, features, and commercial apps; Section 4 presents the main findings, standards (norms), and regulations; and Section 5 concludes the study.

## 2 METHODS

### 2.1 Data sources and search strategy

We performed a literature search in the online databases Scopus, Elsevier, IEEE, and PubMed, which provide access to over 94 million records and 330,000 worldwide research books and publications [17]. Selecting appropriate search terms proved difficult due to the different terminology used for health records. Our initial search term, 'Diabetes AND PHR,' yielded only 101 related results. To obtain more relevant results, we refined our search to 'diabetes AND mobile AND technolog*', focusing on smartphones, tablets, sensors, and other mobile technologies used in healthcare.

### 2.2 Selection criteria for studies

In this search, we apply the selection criteria detailed in Table 1, which outlines all inclusion and exclusion criteria. Our goal is to capture terms related to PHR, EHR, and other aspects of medical records related to diabetes. Most results lack interaction or connectivity with PHR, as mentioned in [18].

**Table 1.** Selection criteria for studies

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| English language. | Editorial review or survey. |
| Spanish language. | Lack of interaction with PHR/EHR or any other health repository. |
| Year of publication: all years. | It is not an app or system. |
| Document type: all types. | It is not related to diabetes as primary illness. |
| Use of PHR, EHR or other health term. | Use EHR/PHR only to obtain the sample data or to upload data. |

## 2.3 Study selection process

The paper selection process is shown in Figure 1. We initially imported 2019 results into the Mendeley Reference Manager, eliminating 23 duplicates. We also removed 69 records because they were reports, editorials, or surveys, while 56 records were inaccessible. This left 1871 records, from which we used selection criteria to exclude 1738 records that did not match the objectives of the study. Of the remaining 133 records, we excluded 39 reviews, four unrelated to PHR, 46 that did not focus on applications, eight where diabetes was not the primary illness, and 17 that used her or PHR only for sampling or manual data uploads. Ultimately, we reviewed the full texts of 19 studies relevant to diabetes and PHR for our analysis.

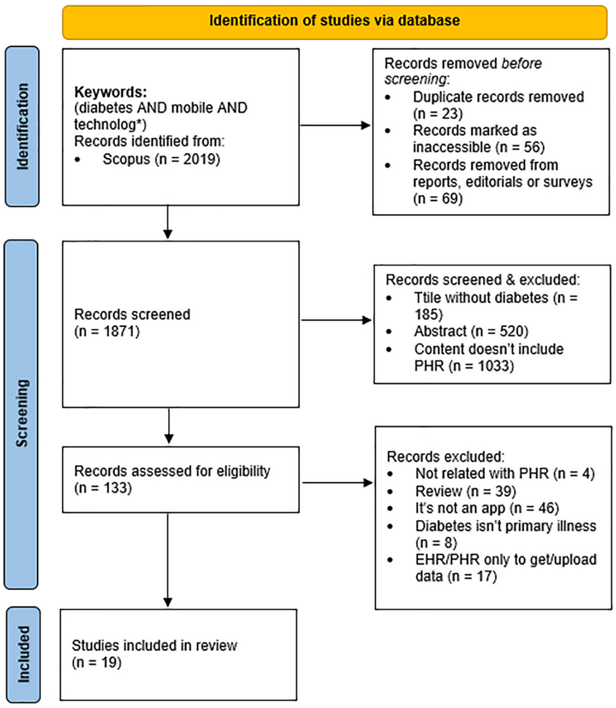


**Fig. 1.** Flow diagram for article selection

# 3 RESULTS

## 3.1 About term selection

A key challenge was identifying the correct terms for searching the database. Between 2005 and 2024, numerous terms were used to describe health data, health records, and health systems, resulting in a total of 64 relevant terms. We categorized these into two main areas: systems or technologies and data. Figure 2 displays the 52 concepts used by authors that we named as health technologies. The varied terminology leads to misinformation and confusion in literature searches, as different authors employ varying concepts for similar information. Some use generic terms such as mobile health or mHealth, while others opt for specific terms such as digital health, distal technologies, or wireless medicine, complicating effective term selection for information retrieval. Based on the information found, we suggest unifying the terminology to mobile health technology or mHealth technology because they are the most used terms.

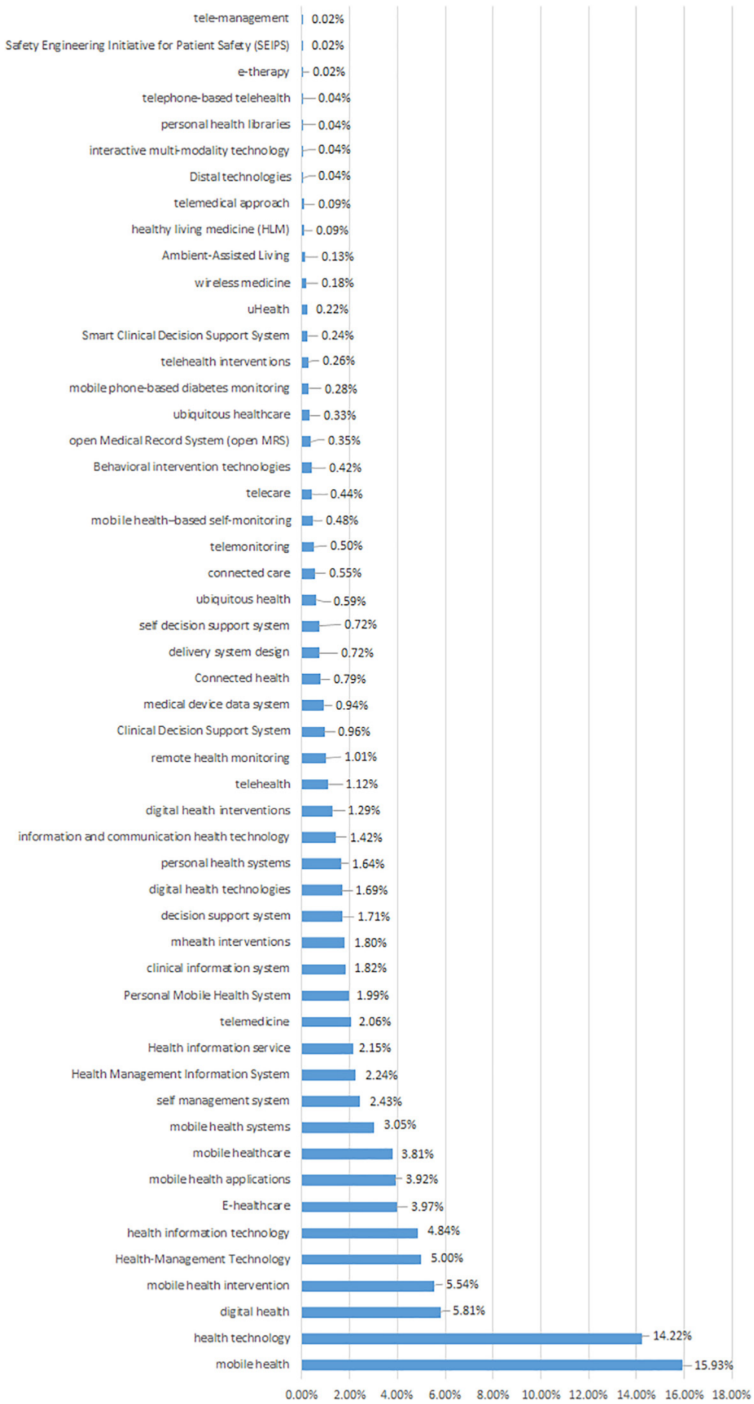


**Fig. 2.** Concepts related to health technologies

A similar issue arose with health data terminology, we referred to as medical records. As depicted in Figure 3, various authors use different interchangeably to describe medical records, such as personal electronic medical record, patient medical record, or electronic stand-alone personal health record, as synonyms for PHR. Based on the information found, we suggest electronic personal health record or ePHR since these terms cover all the concepts used for medical records.

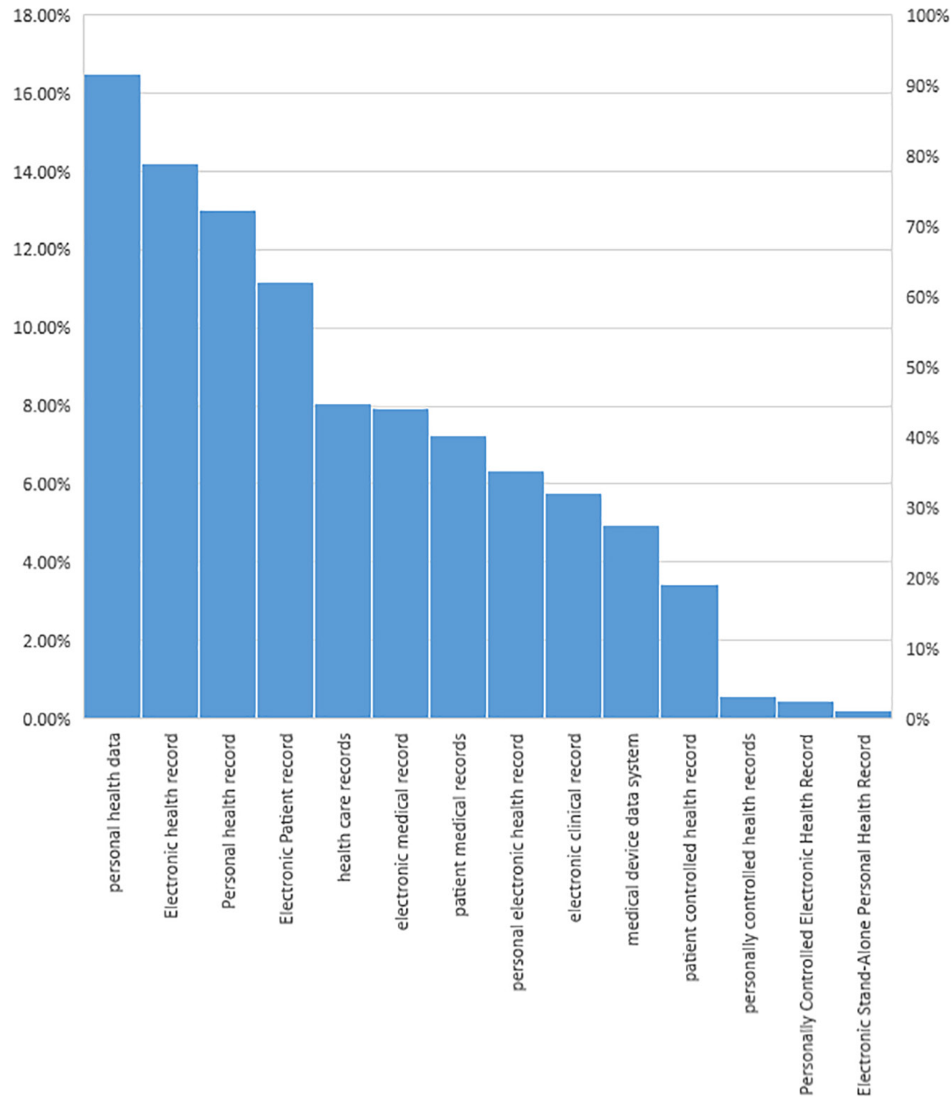


**Fig. 3.** Concepts related to medical records

These observations led us to choose 'Diabetes mobile technology' over 'Diabetes PHR' as the focus of our literature review. Moreover, the abundance of research on diabetes provided valuable insights into various approaches for interacting with patient records.

## 3.2 Principal findings of the literature reviewed

Our review enabled us to identify, select, and include various systems, frameworks, applications, and models presented by different authors, as shown in Table 2.

**Table 2.** Characteristics of the selected studies

| Ref. No | PHR Interaction | Monitoring | Notifications | Additional Users | Parameters Included |
|---|---|---|---|---|---|
| [14] | Mentions it | Via EMR | Not included | Medical staff | BMI, BP, CHO, HD, PA, TG, GLU |
| [19] | HL7 | Included | Included | – | GLU, PA, Insulin, Food diary |
| [20] | MyChart | Included | Included | Medical staff | GLU |
| [21] | FHIR | Included | Not included | Medical staff | GLU, PA, Insulin, Carbohydrates |
| [22] | Health Vault[1] | Included | Not included | Parents | GLU |
| [23] | HL7 | Not included | Included | – | GLU, educational content, PA, Food diary, Insulin |
| [24] | MyChart/Tidepool | By reviewing | Not included | Caregivers | GLU |
| [25] | MyChart | Included | Not included | Medical staff | GLU |
| [26] | Joslin/MyChart | Included | Included | Medical staff | GLU, Food diary, PA, behavioral interventions |
| [27] | Open MRS | Included | Included | Medical staff | Anthropometric, BP, GLU |
| [28] | Clarity | Included | Included | Medical staff | GLU |
| [29] | HL7 | Included | Included | Medical staff | GLU, BP |
| [30] | HL7-FHIR | Included | Included | Medical staff, caregivers | GLU, PA, food diary |
| [31] | Epic | Included | Included | Medical staff, caregivers | GLU, BP, PA, Weight |
| [32] | Apple HealthKit/MyChart | Included | Included | Medical staff | PA |
| [33] | TreC | Included | Included | – | GLU, Drugs |
| [13] | HL7 | Not included | Not included | – | PA, Food diary |
| [34] | SANTA-HIS | Included | Not included | Medical staff | PA |
| [35] | Sana.PCHR | Included | Included | Medical staff, government, humanitarian organization | Manual input: GLU, CHO, TG, urine analysis, potassium, creatinine, others |

*Notes:* GLU = Glucose; PA = Physical Activity; BP = Blood Pressure; BMI = Body Mass Index; HD = Heart Disease; CHO = cholesterol; TG = Triglycerides.
[1]Discontinued.

Brew-Sam and Chib reviewed 442 free downloadable apps from the app store and play store—142 for iPad, 150 for iPhone, and 150 for Android—of which 121 were analyzed [36]. Results showed that 85% targeted adults; 33% offered data export features, and 29% allowed data forwarding via email or print. However, most did not enable automatic access to patient data. The lack of diabetes control and monitoring contributes to significant healthcare costs globally. In the United States (US), expenses are estimated at $294.6 billion; in China, $109 billion; in Brazil, $52.3 billion [37, 38]; in the United Kingdom (UK), projected annual spending may reach $21.46 billion by 2035 [38]; and in Mexico, diabetes costs exceed 2% of gross domestic product (GDP), with projections of a possible doubling within the next decade [39].

There is an urgent need for cost-effective solutions to improve diabetes management and reduce complications and treatment costs [38]. Various strategies have been proposed, including short message service (SMS), social networks (e.g., WhatsApp, Facebook, Twitter, etc.), fog computing, neural networks, machine learning, Internet of Things (IoT), artificial intelligence (AI), deep learning, chatbots, federated learning, blockchain, notifications, reminders, agents, and others.

Effective diabetes self-management is crucial, with research emphasizing the importance of support from healthcare professionals and social networks, as mobile applications alone are insufficient for maintaining self-control [36]. Long-term efficacy frequently depends on integration within the doctor-patient relationship. Additionally, various commercial healthcare applications have been developed, with their key characteristics summarized in Table 3.

**Table 3.** Commercial systems or apps

| System/App | Data Format | License Type | Countries Where is Available | Platform | Cost (from November 2024) |
|---|---|---|---|---|---|
| FitBit | Excel | Proprietary | +40 | android iOS | $99–$400 US Device + $9.99 US Membership Monthly |
| Epic/MyChart | HL7 | Proprietary | +10 | android iOS | $1200–$500000 US per year |
| Tebra (patientPOP) | – | Proprietary | +10 | android | $700–$900 US per month |
| Apple Healthkit | FHIR | Proprietary | 3 | iOS, watchOS | – |
| Clarity | HL7, FHIR, HIPAA | Proprietary | 2 | android iOS Web | $999 per month integration |
| Oracle Health | HL7, FHIR | Proprietary | +20 | – | Not available $25 US per user/month (previous Cerner Corp) |
| Samsung SDS Nexmed EHR | HL7 | Proprietary | – | – | – |
| Veradigm | HL7, FHIR | Proprietary | 1 | android iOS Web | $59–$149 + US per month |
| Orion Health | HL7, FHIR | Proprietary | 15 | android iOS Web | $500–$5,000 US per month |

Most of these systems or applications are limited to the US, Canada, and the UK, excluding other countries due to issues as incompatibility, lack of interoperability, high costs, regulations barriers, among others.

A key finding from this literature review was the identification of various features and categories associated with diabetes applications and systems. Figure 4 summarizes these features, which are classified into the following categories: interaction, data, control access, reminders, rewards, agenda, profile personalization, and advice and support.

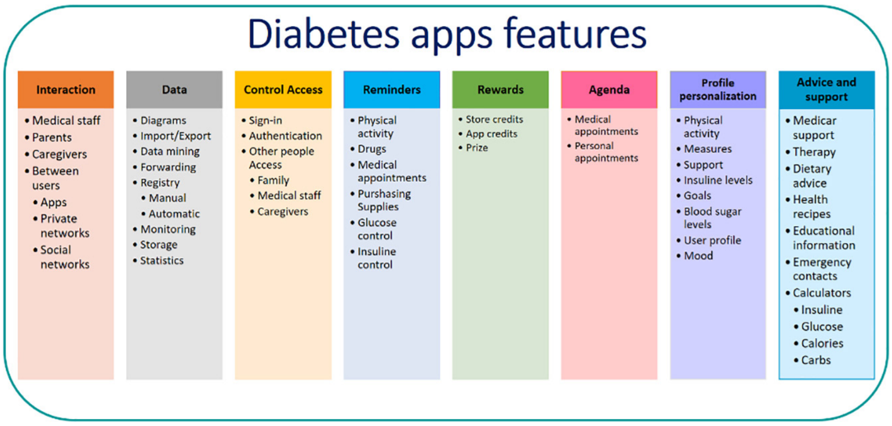


**Fig. 4.** Diabetes apps features

The *interaction* category encompasses communication between users and medical staff or caregivers through apps, social networks, and private channels using SMS, chats, chatbots, virtual assistants, and virtual meetings. The *data* category includes elements related to storage, statistics, import or export, data mining, and monitoring, both manually and through sensors measuring glucose, weight, calories, carbs, and blood pressure. *Control access* refers to sign-in processes and the ability of patients, caregivers, and medical staff to access defined health information. The *reminder* category includes alerts for exercise, medication, appointments, and glucose or insulin checks. The *rewards* feature allows users to earn credits or prizes within the app or for stores. The *agenda* category enables users to manage medical and personal appointments, while *profile personalization* gives users the ability to set goals related to blood sugar levels, physical activity, and other personal metrics. Finally, the *advice and support* category offer medical assistance, therapy resources, dietary advice, healthy recipes, educational information, emergency contacts, and calculators for calories, insulin, glucose, and carbs.

# 4 DISCUSSION

## 4.1 Principal findings

In 2020, 100,000–500,000 health-related applications were available in the Apple App Store and Google Play Store. While the exact number of diabetes-specific apps is unknown, most focus on diabetes consultation and tele management services [37, 40]. In [36] a study of 121 apps found that only 9.2% allowed data export and the same percentage enabled communication via private social networks. As shown in Table 3, all commercial apps rely on proprietary technologies, which complicates integration and interaction among devices from different brands. For instance, Apple Health is only compatible with Apple devices such as the iPhone, iPad, and Apple Watch [41].

The wide variety of health systems and applications has led to a lack of interoperability among services. The healthcare ecosystem includes patients, providers, insurance companies, third-party associates, and government agencies, making it challenging to achieve the interoperability needed to share information in a timely manner [42] as they use specific hardware and software to collect and access data [21].

In the US, there are 701 certified products listed in the certified health IT product list (CHPL), a comprehensive resource of health information technologies that have been tested and certified by the office of the national coordinator (ONC) for Health IT Certification [43]. Similarly, organizations and agencies in other countries define reference frameworks or maintain lists of certified health IT products. These include the health and social care network (HSCN) in UK [44], the Australian Digital Health Agency [45], the Canada Health Infoway [46], the European health data space (EHDS) [47].

## 4.2 Norms and regulations

Each country has its own health regulations and electronic records management systems. While most stakeholders in Europe and the US are generally familiar with the regulatory processes for pharmaceuticals and medical devices, awareness of regulations related to digital health applications remains comparatively low [40].

In the US, the Food and Drug Administration (FDA) ensures public health by overseeing the safety, efficacy, and security of drugs, biological products, medical devices, food supplies, cosmetics, and radiation-emitting products [40, 48]. The FDA also establishes policies for mobile medical device software and electronic medical records [49]. Additionally, organizations such as the assistant secretary for technology policy (formerly the ONC for Health IT) coordinate national health IT efforts, while the National Evaluation System for Health Technology Coordinating Center (NESTcc) evaluates medical devices using real-world evidence [50].

In the European Union (EU), the Health and Food Safety Commission oversees food safety and health policies, monitoring the implementation of related laws [42, 51]. The Public Health European Commission is responsible for coordinating health actions, treatments, health system improvements, and medical device regulations [52]. While the EU set regulations for medical devices, individual member countries remain primarily responsible for organizing and delivering healthcare services [42].

In Mexico, NOM-004-SSA3-2012 establishes the scientific, ethical, technological, and administrative criteria required in the preparation, integration, use, management, archiving, conservation, ownership, and confidentiality of the clinical record [53].

The World Health Organization (WHO) introduced the "Classification of Digital Interventions, Services, and Applications in Health (CDISAH)," which categorizes digital health interventions aimed at improving health outcomes. This framework seeks to facilitate communication among health and technology stakeholders—including government agencies, health providers, and researchers—by providing a common language to articulate problems and solutions in digital health interventions [54].

### 4.3 Social support network

Social media can serve as a motivational tool for individuals managing their diabetes by facilitating the application of their knowledge [55]. Positive correlations exist between social support and eHealth literacy, particularly for older adults, as it provides access to information, resources, and encouragement, fostering their engagement with the Internet and mHealth tools [56]. A strong online community exists for people affected by diabetes, including forums specifically designed for support [57]. Furthermore, the potential of social media as a platform to enhance health behaviors through social comparison theory remains underexplored; individuals may adopt certain behaviors to gain validation or "fit in" [55].

Overall, leveraging social media and online communities can enhance diabetes self-management by offering support, information, and motivation to individuals. Further, exploring the intersection between social media engagement and health behavior may yield deeper insights into effective strategies for motivating health-related change among patients.

To summarize this section, we conclude that a digital health record system or application designed for the management of type 2 diabetes must effectively address the following three functions:

1. **Patient access to health information** – Patients must have access to their health data to better manage their condition [14].
2. **Integration of smart technologies and communication** – A smart system that incorporates the latest IT technologies and enables effective communication is essential for improving diabetes care and optimizing the use of available medical resources [15].

3. **Regular screening and monitoring** – Ongoing screening and monitoring are crucial for preventing complications such as cardiovascular disease, stroke, neuropathy, and others [10, 16].

## 5 CONCLUSIONS

This paper presents a range of technologies, systems, applications, and strategies for the control, treatment, and monitoring of diabetes, highlighting areas of opportunity identified during our literature review. Our main contribution lies in recognizing the extensive variety of proposals within the healthcare sector, with particular emphasis on the diverse terminology used to describe systems and applications related to diabetes management.

For more than 20 years, the problem of interoperability in the development of (Fast Healthcare Interoperability Resources) and systems has resulted in different solutions or technologies, making their integration and use challenging.

Our review found that EPIC MyChart is the most widely used health system in the US, while HL7 leads in information exchange applications. Efforts are currently underway to incorporate the new HL7 version, FHIR (Fast Healthcare Interoperability Resources), into existing systems. Significant investments by companies such as Samsung, with its Nexmed EHR solution, and Oracle's acquisition of Cerner Corporation for $28.3 billion in 2022, indicate substantial opportunities and growing interest in the health technology sector.

The search for information on managing the clinical histories of diabetes patients revealed a contradiction due to the diversity of associated concepts. We recommend that future research includes the term "medical record," as it encompasses EHR, PHR, and other relevant derivatives, thereby improving the comprehensive and accuracy of the results.

The goal of this study was to identify reliable sources of information for PHR, by assessing their advantages, limitations, and stakeholders, with the aim of creating an updated and practical health record system to support decision-making. Our findings indicate that effective diabetes management requires ongoing patient involvement and support, highlighting the critical role of a social support in motivated sustained treatment. The ability for patients to choose who is part of this network and to control real-time access to their data will inform our future work. As a next step, we propose the use of microservices to design an integrative solution for T2DM and medical records.

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