Digital technologies in the care of people with diabetes during the COVID-19 pandemic: a scoping review

Tecnologias digitais no cuidado a pessoas com diabetes durante a pandemia de COVID-19: revisão de escopo

Tecnologías digitales en la atención de personas con diabetes durante la pandemia de COVID-19: revisión del alcance

iD **Francisca Diana da Silva Negreiros**[1]

iD **Açucena Leal de Araújo**[2]

iD **Samuel Miranda Mattos**[3]

iD **Tatiana Rebouças Moreira**[1]

iD **Virna Ribeiro Feitosa Cestari**[2]

iD **Lucilane Maria Sales da Silva**[2]

iD **Thereza Maria Magalhães Moreira**[2,3]

[1] Universidade Federal do Ceará, Hospital Universitário Walter Cantídio, Fortaleza, CE, Brazil.

[2] Universidade Estadual do Ceará, Programa de Pós-Graduação em Cuidados Clínicos em Enfermagem e Saúde, Fortaleza, CE, Brazil.

[3] Universidade Estadual do Ceará, Programa de Pós-Graduação em Saúde Coletiva, Fortaleza, CE, Brazil.

ABSTRACT

Objective: To map evidence on the use of digital technologies in the care of people with diabetes during the COVID-19 pandemic. **Method:** This is a scoping review, based on the JBI manual, which included scientific articles and gray literature from nine primary and seven secondary databases. Articles were independently assessed by two reviewers. Rayyan® was used to select the studies. The description of study characterization is presented in a table and tables, ending in a narrative synthesis. **Results:** A total of 1,964 studies were identified and, after selection, 23 publications remained for analysis. It turned out that telemedicine was used in all studies and remote consultation support technologies included continuous glucose monitoring devices, glucose data analysis software, insulin delivery systems, applications, audio and/or voice communication devices, which facilitated remote diabetes mellitus monitoring and management. **Conclusion:** Telehealth, monitoring technologies, insulin delivery systems and communication devices were tools used to monitor patients with diabetes during the pandemic.

DESCRIPTORS

Technology; Educational Technology; Mobile Applications; Coronavirus Infections; Severe Acute Respiratory Syndrome; Diabetes Mellitus.

Corresponding author:
Francisca Diana da Silva Negreiros
Rua Pastor Samuel Munguba, 1290
60430-370 – Fortaleza, CE, Brazil.
negreiros.diana@gmail.com

INTRODUCTION

The COVID-19 pandemic imposed the need for new strategies and adaptations of health services to act in the face of the reality of social distancing. This fact provided an opportunity to improve processes and flows in the use of digital health technologies, as these tools can improve access and quality of care, being effective in facilitating contact between health professionals and patients[1].

A study identified that most of the technologies implemented in the pandemic included healthcare providers and consumers, due to the extreme measures imposed to prevent the spread of COVID-19, interrupting the provision of health services for many patients, especially those with chronic conditions[2]. In this perspective, multiple countries sought to adopt innovations in health, with the aim of providing continuous care to clients with chronic conditions and at risk for COVID-19, such as patients with diabetes mellitus (DM).

Since the beginning of the new coronavirus pandemic, a bidirectional relationship between COVID-19 and DM has been pointed out. On the one hand, people with DM are at greater risk of developing complications when they have COVID-19, and on the other hand, SARS-CoV-2 could act as a diabetogenic agent as it is capable of causing direct damage to the pancreas, which can worsen hyperglycemia and even induce DM in individuals without the disease[3].

Moreover, people with DM infected with SARS-CoV-2 have a higher rate of hospitalization, severe pneumonia, and higher mortality compared to individuals without DM. Therefore, blood glucose and comorbidity management must be individualized to reduce the incidence of complications and reduce the burden on health systems[3]. Thus, it is essential to use digital technologies with these patients, during the pandemic, to continuously monitor the clinic, allowing better management of the disease.

Although studies on prevention, treatment and COVID-19 in DM have been developed[3–5], so far few studies on the use of digital technologies in health[2] and in the care of people with DM during the pandemic have been identified[6], it is necessary to update and continue mapping new evidence to support technology-mediated DM care during the pandemic. Therefore, the objective was to map the evidence on the use of digital technologies in the care of people with DM during the COVID-19 pandemic.

METHOD

Design of Study

This is a scoping review, based on the methodological framework developed by the Joanna Briggs Institute (JBI)[7] and on the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR, see Supplementary File 1)[8]. The review was registered in the Open Science Framework (Osf.io/wqd4p), with identification DOI 10.17605/OSF.IO/WQD4P.

The review was developed in five steps[7,9]: (1) research question identification; (2) survey of relevant studies, which would enable the breadth and scope of the review; (3) study selection according to predefined criteria; (4) data mapping; and (5) presentation of results.

Data Collection

To structure the research question (step 1), the mnemonic PCC (Population, Concept, Context) was used)[7]: P consisted of people with DM; C in digital technologies; and the C in COVID-19. Thus, the guiding question was: what is the evidence on the use of digital technologies in the care of people with DM during the COVID-19 pandemic?

The elaboration of the search equation received assistance from a librarian in the health area, for greater sensitivity and refinement. The searches took place on March 17, 2021 in the Online Medical Literature Analysis and Retrieval System (MEDLINE) via PubMed, MEDLINE via Elton B. Stephens Company (EBSCO), MEDLINE via Virtual Health Library (VHL), Latin American and Caribbean Health Science Literature (LILACS), Web of Science, Scopus, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Library and Embase databases.

Gray literature was retrieved from seven sources: Google Scholar, Brazilian Digital Library of Theses and Dissertations (BDTD – *Biblioteca Digital Brasileira de Teses e Dissertações*), Theses and Dissertations Catalog (CTD – *Catálogo de Teses e Dissertações*) of the Coordination for the Improvement of Higher Education Personnel (CAPES – *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*), OpenGrey, New York Academy of Medicine (NYAM) Library, ProQuest Dissertations and Theses (PQDT) and Open Access Theses and Dissertations (OATD). The retrieval of documents in Google Scholar was performed on the first ten pages, with a 2019-2021 time filter, as the theme emerged at the end of 2019. The search strategy was built with three controlled vocabularies in health, Health Science Descriptors (DECS), Medical Subject Headings (MeSH), EMTREE and natural language, together with Boolean operators AND and OR, to obtain a wide spectrum of results in different databases[10]. In the databases surveyed, we used the structure presented in Chart 1.

Selection Criteria

As eligibility criteria for this scoping review, the following were established: publications on care for people with DM mediated by digital technologies during the pandemic, from the year 2019, beginning of the first COVID-19 reports, without language restrictions. As for study design, primary and secondary, empirical, quantitative and qualitative research of any design or methodology were chosen. Letters to the editor, abstracts in event proceedings, incomplete articles, studies in the design phase or without results were excluded.

After the search developed according to the strategy outlined above, the studies were selected (step 3). The results obtained in the databases were exported to the Rayyan® reference manager, developed by the Qatar Computing Research Institute (QCRI)[11], for removal of duplications, selection and screening of studies by two researchers, independently, with differences being resolved with the participation of a third examiner. The first phase consisted of reading titles and abstracts. Studies that met the

Chart 1 – Search strategy for document retrieval. Fortaleza, CE, Brazil, 2021.

	P	C	C
Extraction	People with diabetes mellitus Diabetes Mellitus	Digital technologies	COVID-19
Conversion	Diabetes Mellitus	Technology	Coronavirus Infections
Construction	diabetes OR diabetic OR "diabetic patient"	"digital technology" OR "technological tool" OR "e-learning" OR "e-schooling" OR "electronic education" OR "electronic educational technology" OR "electronic learning" OR "on-line education" OR "on-line learning" OR "online education" OR "online learning" OR software OR "software application" OR "software applications" OR "software app" OR "software apps" OR "computer program" OR "computer programme" OR "computer programming" OR "biomedical software" OR "healthcare software" OR "health management software" OR "mobile application" OR app OR application "mobile app" OR "mobile applications" OR "mobile apps" OR "portable software app" OR "portable software application" OR "portable software applications" OR "portable software apps" OR "tablet application" OR "mobile health application" OR "m-Health" OR "mobile health" OR "mobile healthcare" OR telehealth OR "e-health" OR "ehealth" OR "tele-health" OR telemedicine "tele medicine" OR telenursing OR "tele-nursing" OR "mobile phone" OR smartphone OR "smart phone" OR smartphones OR cellphone OR "cell phone" OR "cell phones" OR cellphone OR cellphones OR "cellular phone" OR "cellular telephone" OR "mobile telephone" OR tablet OR computer OR internet OR device OR devices OR "electronic device" OR "technological device" OR game OR games OR gadget OR simulator OR podcast OR "audio book" OR e-book OR "electronic book" OR primer OR chat OR chatbot OR "virtual learning" OR "virtual learning environment" OR "virtual learning environments" OR "social networks" OR social network OR "distance education" OR "audio recording" OR audiorecording OR "sound recording" OR avatar OR "instant messenger" OR "MOOC" OR "MOOCs" OR "personal digital assistants" OR "virtual libraries" OR "virtual library" OR "virtual reality" OR website OR "online course" OR "on-line course" OR "online courses" OR "on-line courses" OR video OR "video game" OR videogame OR videoconferencing OR movie OR internet OR "internet use" OR online OR "on-line" OR "internet of things" OR "data base" OR "data bank" OR database OR "knowledge base" OR "knowledge bases" OR "knowledge database" OR "artificial intelligence" OR "machine intelligence" OR "machine learning" OR "learning machin" OR "learning machines" OR automation OR automatization OR computerization OR robotics OR robot	"coronavirus disease 2019" OR "SARS-CoV-2 infection" OR "SARS-CoV-2" OR "2019-nCoV disease" OR "2019-nCoV infection" OR "COVID 19" OR "COVID-19" OR "COVID 2019" OR "nCoV 2019 disease" OR "nCoV 2019 infection" OR "novel coronavirus 2019 disease" OR "novel coronavirus 2019 infection" OR "novel coronavirus disease 2019" OR "novel coronavirus infection 2019" OR "Wuhan coronavirus disease" OR "Wuhan coronavirus infection" OR "Severe acute respiratory syndrome coronavirus 2" OR "2019 new coronavirus" OR "2019 novel coronavirus" OR "2019-nCoV" OR "HCoV-19" OR "human coronavirus 2019" OR "nCoV-2019" OR "novel 2019 coronavirus" OR "novel coronavirus 2019" OR "SARS Coronavirus 2" OR "SARS-CoV-2" OR "Wuhan coronavirus" OR "Wuhan seafood market pneumonia virus"
Use	diabetes OR diabetic OR "diabetic patient" AND "digital technology" OR "technological tool" OR "e-learning" OR "e-schooling" OR "electronic education" OR "electronic educational technology" OR "electronic learning" OR "on-line education" OR "on-line learning" OR "online education" OR "online learning" OR software OR "software application" OR "software applications" OR "software app" OR "software apps" OR "computer program" OR "computer programme" OR "computer programming" OR "biomedical software" OR "healthcare software" OR "health management software" OR "mobile application" OR app OR application "mobile app" OR "mobile applications" OR "mobile apps" OR "portable software app" OR "portable software application" OR "portable software applications" OR "portable software apps" OR "tablet application" OR "mobile health application" OR "m-Health" OR "mobile health" OR "mobile healthcare" OR telehealth OR "e-health" OR "ehealth" OR "tele-health" OR telemedicine OR "tele medicine" OR telenursing OR "tele-nursing" OR "mobile phone" OR smartphone OR "smart phone" OR smartphones OR cellphone OR "cell phone" OR "cell phones" OR cellphone OR cellphones OR "cellular phone" OR "cellular telephone" OR "mobile telephone" OR tablet OR computer OR internet OR device OR devices OR "electronic device" OR "technological device" OR game OR games OR gadget OR simulator OR podcast OR "audio book" OR e-book OR "electronic book" OR primer OR chat OR chatbot OR "virtual learning" OR "virtual learning environment" OR "virtual learning environments" OR "social networks" OR social network OR "distance education" OR "audio recording" OR audiorecording OR "sound recording" OR avatar OR "instant messenger" OR "MOOC" OR "MOOCs" OR "personal digital assistants" OR "virtual libraries" OR "virtual library" OR "virtual reality" OR website OR "online course" OR "on-line course" OR "online courses" OR "on-line courses" OR video OR "video game" OR videogame OR videoconferencing OR movie OR internet OR "internet use" OR online OR "on-line" OR "internet of things" OR "data base" OR "data bank" OR database OR "knowledge base" OR "knowledge bases" OR "knowledge database" OR "artificial intelligence" OR "machine intelligence" OR "machine learning" OR "learning machin" OR "learning machines" OR automation OR automatization OR computerization OR robotics OR robot AND coronavirus disease 2019" OR "SARS-CoV-2 infection" OR "SARS-CoV-2" OR "2019-nCoV disease" OR "2019-nCoV infection" OR "COVID 19" OR "COVID-19" OR "COVID 2019" OR "nCoV 2019 disease" OR "nCoV 2019 infection" OR "novel coronavirus 2019 disease" OR "novel coronavirus 2019 infection" OR "novel coronavirus disease 2019" OR "novel coronavirus infection 2019" OR "Wuhan coronavirus disease" OR "Wuhan coronavirus infection" OR "Severe acute respiratory syndrome coronavirus 2" OR "2019 new coronavirus" OR "2019 novel coronavirus" OR "2019-nCoV" OR "HCoV-19" OR "human coronavirus 2019" OR "nCoV-2019" OR "novel 2019 coronavirus" OR "novel coronavirus 2019" OR "SARS Coronavirus 2" OR "SARS-CoV-2" OR "Wuhan coronavirus" OR "Wuhan seafood market pneumonia virus"		

inclusion criteria were analyzed in the second phase, by reading the full manuscripts. Finally, manual searches were performed in the references of the included studies.

DATA ANALYSIS AND TREATMENT

The selected studies were analyzed at different times for mapping (step 4). First, data were independently extracted by two reviewers using Microsoft Excel® spreadsheets. The information was confirmed by the third reviewer and differences and doubts were resolved, in debates, until a consensus was reached among the authors. Information mapping took place based on the JBI instrument to characterize the studies[7]. The extraction chart included authorship, publication journal, country of origin, year of publication, objectives, design, sample number and main results regarding the identification of the technology used to monitor a person with DM. The description of the study characterization is presented in a table and tables, ending in a narrative synthesis.

RESULTS

The search identified 1,964 potentially relevant studies in the databases and other sources, of which 931 were removed because they were duplicates. Thus, 1,033 publications were analyzed by title and abstract, and 922 studies were excluded for not meeting the inclusion criteria. Therefore, 111 articles, along

with reference lists, were fully assessed for eligibility. In the end, 22 documents were selected and a publication was added to the list of references, totaling 23 articles to compose the sample[12–34].

Figure 1 shows the process of searching, excluding and selecting the studies found, according to the PRISMA-ScR recommendations[8].

Mostly, the articles were developed in Spain (n = 4), India (n = 3) and Brazil (n = 2), followed by studies published in the United States of America (USA), Singapore, United Kingdom, Israel, Italy, Australia, Colombia, Japan, Germany, France, Saudi Arabia, China, England and Greece, which published one article each. The documents were in English, being publications from 2021 (n = 13) and 2020 (n = 10).

As for journals, they were not limited to those specific to the areas of endocrinology and diabetes (n = 18), but also in medicine (n = 4) and nursing (n = 1). The studies were cross-sectional (n = 7), clinical observations (n = 1), case series (n = 1), cohort (n = 7), retrospective observational (n = 4), case reports (n = 1), randomized clinical trial (n = 2). A total of 8,001 people participated in the studies, of which 5,904 had type 2 DM, 1,843 type 1 DM, 43 had gestational DM, one had pancreatogenic DM, and 210 did not describe any type of DM (Chart 2).

The following are the main results and technologies used in the care of people with DM during the COVID-19 pandemic (Chart 3).
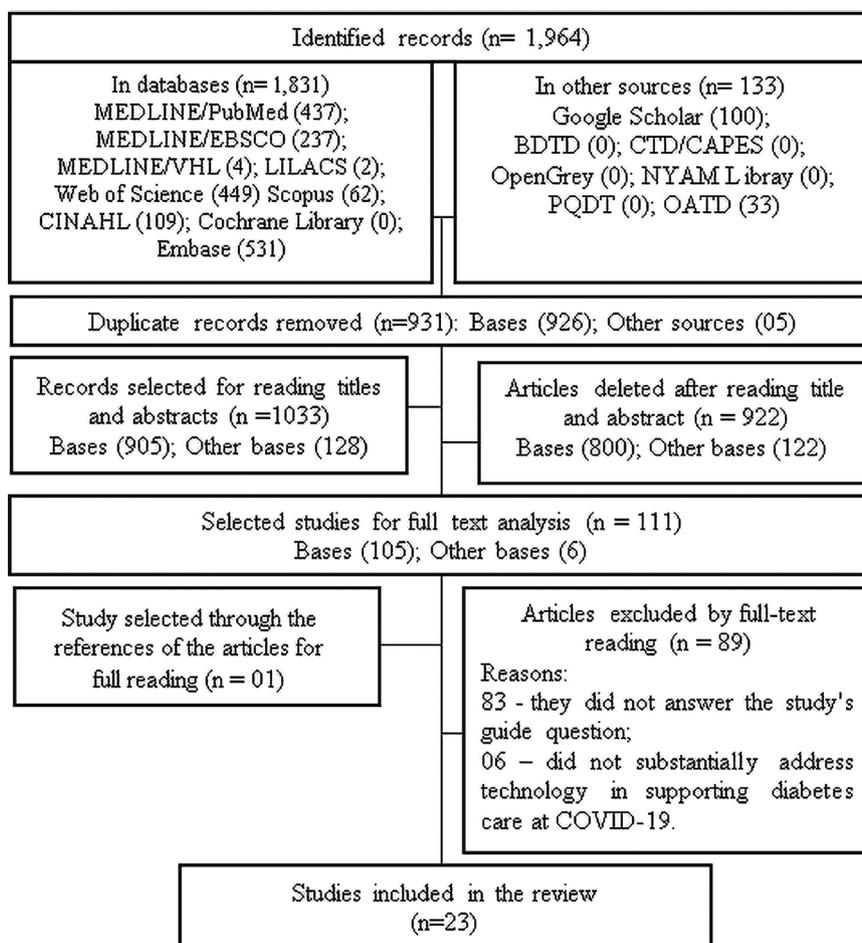

Figure 1 – Flowchart of selection of publications for scoping review according to PRISMA-ScR recommendations[8]. Fortaleza, CE, Brazil, 2021.

Chart 2 – Characterization of articles included in this review. Fortaleza, CE, Brazil, 2021.

Articles	Authors/Year/Country/Journal	Objectives	Design/sample
1.	Albert et al., 2020[12]/Spain/Diabetes Res Clin Pract.	Describe the experience in remote management of women with gestational diabetes mellitus (GDM) during the COVID-19 pandemic.	Cross-sectional/20 women with GDM.
2.	Jiwani et al., 2021[13]/USA/Geriatr Nurs.	Assess the acceptability and experience of a participant of a behavioral lifestyle intervention using Fitbit Technology in older adults with overweight and obesity to manage type-2 diabetes mellitus (2DM) in the midst of the COVID-19 pandemic.	Cross-sectional/18 elderly with 2DM.
3.	Joshi et al., 2020[14]/India/Diabetes Res Clin Pract.	Describe a telemedicine approach for the follow-up of people with DM under restrictions imposed by the COVID-19 pandemic.	Cross-sectional/103 people with DM, 102 with 2 and 1DM with secondary pancreatogenic DM.
4.	Lim et al., 2020[15]/Singapore/J Adolesc Health.	Describe a nurse-led telehealth initiative to provide DM care in adolescents during the 2019 coronavirus disease pandemic.	Clinical observations/35 adolescents, 28 with 1DM and 7 2DM.
5.	Shin et al., 2020[16]/UK and USA/ Diabetes Care.	Describe the two-center approaches to managing diabetic foot ulcer problems to address the challenge presented by the pandemic.	Case series/05 people with 2DM.
6.	Rachmiel et al., 2021[17]/Israel/Acta Diabetol.	Assess the feasibility of carrying out a single multidisciplinary telehealth intervention and its short-term impact on blood glucose metrics in young people with 1DM.	Real-life observational multicenter cohort study/195 people with 1DM.
7.	Predieri et al., 2020[18]/Italy/Front Endocrinol (Lausanne).	Investigate the effects of changes in daily routine, due to COVID-19 blockade, on glycemic management, in a cohort of children and adolescents with 1DM using continuous glucose monitoring in real time.	Observational, retrospective longitudinal study/62 children and adolescents with 1DM.
8.	Kavitha et al., 2020[19]/India/Diabetes Metab Syndr.	Discuss the pros and cons of telemedicine or "tele-podiatry" in diabetic foot treatment.	Report of three cases/03 people with 2DM and diabetic foot ulcer.
9.	Varnfield et al., 2021[20]/Australia/ Diabetes Technol Ther.	Assess the adoption and coordination of multidisciplinary care of a mHealth platform called M♡THer, in a cohort of women with an initial diagnosis of GDM.	Cohort study/23 women with GDM.
10.	Tejera-Perez et al., 2021[21]/Spain/ Diabetes Res Clin Pract.	Analyze the effects of confinement between people with type-1 diabetes (1DM) and their caregivers during the COVID-19 crisis and contemporary changes in medical care and patient preferences.	Cross-sectional/769 individuals participated in the research (603 people with 1DM and 166 caregivers).
11.	Gómez et al., 2021[22]/Colombia/ Diabetes Metab Syndr.	Describe the efficacy and safety results of the virtual training program.	Prospective cohort/91 people with 1DM.
12.	Onishi et al., 2021[23]/Japan/J Diabetes Investig.	Assess the effect of telemedicine and the clinic visit on glycated hemoglobin (HbA1c) during coronavirus disease emergency state in 2019.	Retrospective cohort/2,727 people, of which 2,556 had 2DM and the remainder (n = 171) did not describe the type.
13.	Alessi et al., 2021[24]/Brazil/Acta Diabetol.	Assess the impact of teleintervention on mental health parameters in patients with 2DM during the coronavirus disease pandemic in 2019.	Randomized clinical trial/91 people with 2DM participated (46 from the intervention group and 45 from the control group).
14.	Braune et al., 2021[25]/Germany/JMIR Mhealth Uhealth.	Remotely support children with 1DM and their caregivers.	Prospective cohort/28 children with 1DM.
15.	Flocard et al., 2021[26]/France/*Medecine des Maladies Metaboliques*.	Assess the glycemic balance at three and six months of patients with DM followed up by teleconsultation, compared to the group of patients who did not undergo teleconsultation.	Prospective cohort/Of the 491 participants, 145 had 1DM, 307 2DM and 39 other types of DM
16.	Tourkmani et al., 2021[27]/Saudi Arabia/ J Telemed Telecare.	Determine the effect of a virtual integrated care clinic on glycemic management among high-risk patients with 2DM in a chronic disease center in Saudi Arabia.	Prospective study of a single cohort before and after the intervention/130 people with 2DM.
17.	Kang et al., 2021[28]/China/Primary Care Diabetes.	Conduct a randomized controlled trial to confirm the effectiveness of remote management, using a cell phone's WeChat app, in comprehensive DM management during the COVID-19 pandemic.	Randomized clinical trial/160 people with 2DM (80 cases to the intervention group and 80 cases to the control group).
18.	Matheus et al., 2020[29]/Brazil/Arch Endocrinol Metab	Assess the performance of telemonitoring in the detection of clinical and psychological needs and in the adhering to the protection measures imposed by the COVID-19 pandemic, in addition to remote care for patients with 1DM, in a public university center in Brazil.	Cross-sectional/237 people with 1DM.
19.	Viñals et al., 2021[30]/Spain/Acta Diabetol	Assess glucose profile management by patients with 1DM, with a tendency to hypoglycemia, using a sensor-enhanced pump.	Observational and retrospective/59 people with 1DM.

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Articles	Authors/Year/Country/Journal	Objectives	Design/sample
20.	Navis et al., 2021[31]/England/Acta Diabetol.	Analyze and compare glycemic results before and during blockade in a cohort of people with 1DM using flash and continuous glucose monitors.	Retrospective, observational and unicentric assessment/269 people with 1DM.
21.	Anjana et al., 2020[32]/India/Diabetes Technol Ther.	Assess the effects of a prolonged blockade on the adoption of newer technologies (including telemedicine services) and changes in glycemic management in patients with type 2 DM treated at a private tertiary DM treatment center in India.	Cross-sectional/2,510 people with 2DM.
22.	Christoforidis et al., 2020[33]/Greece/ Diabetes Res Clin Pract.	Monitor the effect of coronavirus block age on DM management in children with type 1 DM using an insulin pump equipped with a continuous glucose monitoring system.	Cross-sectional/34 children with 1DM.
23.	Mesa et al., 2020[34]/Spain/Diabetes Res Clin Pract.	Examine the impact of the exceptional scenario on the glucose profile of patients with 1DM prone to hypoglycemia, using independent continuous glucose monitoring.	Observational and retrospective/ 92 people with 1DM.

Chart 3 – Synthesis of mapped articles, according to main results and digital technologies identified in diabetes care. Fortaleza, CE, Brazil, 2021.

Article	Main results	Digital technologies identified
1.	The SineDie app can avoid unnecessary hospital visits, maintaining the best quality of health and reducing physicians' workload for managing GDM.	SineDie for Android phone with artificial intelligence that automatically classifies and analyzes data.
2.	Personal fitness technology (Fitbit®) has the potential to improve 2DM management.	Complementary personal fitness app (Fitbit®) was downloaded to each person's phone, with the support of the research team.
3.	The strategy of using telemedicine, through a team of trained physicians, is an efficient way to provide patient care amidst COVID-19's blockade restrictions.	Telemedicine provided real-time audio consultations over the phone.
4.	The nurse-led telehealth initiative was well received among adolescents with DM and there were no significant adverse effects observed.	Telehealth included a teleconsultation platform, a payment platform, laboratory tests with drug collection and delivery.
5.	The adoption and widespread use of virtual telemedicine consultations proved to be successful, many hospital admissions and treatments were avoided.	Telemedicine for monitoring patients with diabetic foot ulcers.
6.	Pediatric patients and young adults with 1DM benefited from a telehealth visit during the COVID-19 pandemic.	Telehealth included video, telephone and email modalities. Data retrieved from medical files, continuous glucose monitoring systems, and continuous subcutaneous insulin infusion sets (pumps) acquired by Dexcom Clarity, CareLink, and Tidepool softwares.
7.	Overall, glycemic management in children and adolescents with 1DM improved during blockade.	Telemedicine involved the multidisciplinary team that performed educational training. Glucose data was shared through Dexcom Clarity.
8.	Telemedicine or tele-podiatry was effective in managing low-risk individuals with diabetic foot ulcers and useful in referring high-risk individuals to hospital visits, facilitating adequate management.	Telemedicine in the management of diabetic foot were: e-mail, images shared by e-mail or online, text messaging application, video call application and messages and audio call.
9.	The M♡THer mHealth platform for the health care of women with GDM can provide an effective new way to improve multidisciplinary care in the face of COVID-19 disruptions.	The M♡THer app integrates multimedia content delivery via smartphone (iOS/Android), data entry to support women managing GDM from diagnosis to delivery.
10.	Almost all participants agreed with the concept of telemedicine, favoring the telephone and video calls as the preferred means of communication.	Telehealth used the telephone and video calls as means of communication and was assessed through a questionnaire by patients with 1DM during the COVID-19 pandemic.
11.	Virtual training and follow-up using the Carelink platform allows physicians to provide education and is an appropriate option in situations that limit patient access to follow-up centers.	Virtual training and follow-up were performed using the Zoom videoconference application and Medtronic Carelink System software, version 3.1.
12.	Telemedicine and clinic visit were associated with improvement in HbA1c in patients with DM.	Telemedicine made it possible to consult by telephone between professionals' pre-visit and post-visit to patients.
13.	Maintaining remote connections with health professionals during social distancing has the potential to reduce DM-related mental health disorders and emotional distress.	Telehealth interventions, educational materials and clinical care were used. The intervention was a set of strategies to help patients stay healthy during the COVID-19 pandemic, which included phone calls, providing educational skills about healthy lifestyles, and complementing patients' usual clinical care.
14.	The study allowed the care team, patients and caregivers to promote shared decision-making. The results generated will help inform and improve methods of implementing remote and digital DM care in the broader healthcare sector during and after the pandemic.	Caregivers of children with 1DM used a customized version of the open source Tidepool platform to upload continuous glucose monitoring sensor and insulin pump data. Several participants also used other software, such as Dexcom Clarity and Abbott FreeStyle LibreView. A web video chat app for remote visits.

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Article	Main results	Digital technologies identified
15.	Monitoring through telemedicine makes it possible to ensure the follow-up of patients, while extending the time interval between one-to-one consultations, it also facilitates access to care for everyone and limits the movement of patients further away from care structures.	Teleconsultation was assessed using a questionnaire.
16.	Telemedicine was effective in providing adequate care for patients with DM, especially when usual self-care was not possible during the COVID-19 pandemic.	Virtual consultations were used, in calls for staff to communicate with patients. WhatsApp was used to provide written instructions, educational materials, audiovisual resources and more. Short text messaging services were also used.
17.	Using the WeChat app during remote management can improve the target glucose rate without increasing the risk of hypoglycemia.	WeChat App was used during remote query.
18.	Monitoring 1DM patients during the pandemic helped to reduce the need for one-to-one consultations, detect clinical and psychological needs and support patients, in addition to monitoring suspected cases of COVID-19 and adherence to protective measures.	Teleconsultation obtained clinical data, presence of COVID-19 symptoms, lifestyle habits, psychological effects of the pandemic, in addition to the need for support from a mental health professional.
19.	The very restrictive blocking conditions imposed by the COVID-19 pandemic can be successfully managed in terms of glycemic management by the hypoglycemic-prone 1DM population using the advanced sensor-augmented pump.	Review of electronic medical records and databases of individuals with 1DM followed at the DM Unit.
20.	The study showed that sensor-based glycemic outcomes improve during the block period in people with DM equipped with a glucose sensor.	Data were collected from electronic outpatient records and web-based glucose monitoring platforms (Libreview; Abbott diabetes care and Dexcom clarity; Dexcom Inc).
21.	Acceptance of telemedicine facilities remains sub-optimal even among the relatively wealthier Asian Indian population during the COVID-19 pandemic and subsequent blockade, despite high levels of satisfaction among those who used it.	Telemedicine was assessed using a structured questionnaire about preference for online support facilities and use of blood glucose self-monitoring equipment.
22.	Glycemic management during coronavirus blockade can be adequately achieved and be comparable to the pre-blockade period in children with 1DM using a sensor-equipped insulin pump.	Monitoring tools were Medtronic MiniMed 640G Insulin, accompanied with EnliteTM sensor and GuardianTM 2 Link transmitter to load the data into the CareLink system.
23.	The blocking conditions imposed by the COVID-19 pandemic can be successfully managed, in terms of glycemic management, by the hypoglycemic-prone 1DM population using continuous glucose monitoring.	Review of patient charts using multiple daily injections and a Dexcom G5® or FreeStyle Libre® continuous glucose monitoring system. Anonymous data from the Clarity® or Libreview® platforms were also used.

DISCUSSION

This review showed that restrictions arising from COVID-19 provided increased use of telemedicine or telehealth or remote care for the front line in DM management. During the pandemic period, technological innovations in healthcare and the development of new devices to store and transfer web-based data further enable the exchange of information between patients, families and healthcare professionals.

Overall, the effectiveness of virtual visits, through phone calls, text messages, mobile applications or electronic visits, in the context of the COVID-19 pandemic, was described in the studies in this review[12–34]. Additionally, the literature reinforces the evidence that virtual consultations can lead to adequate care during a pandemic or when a one-to-one visit cannot be carried out for any reason. Data sharing and remote visits help maintain or achieve adequate glycemic management through data analysis and therapy adjustments[35].

Furthermore, it was observed that several professional categories that were involved in the research scenarios, as a physician, nurses, podiatrists, diabetologists, nutritional educators, psychologists, social workers and pharmacists, shared decisions on therapeutic adjustments and on the development of educational actions to convince patients to maintain a healthy lifestyle. Research from the United Kingdom has shown that, with increasing familiarity with established systems, DM health professionals will be more open to adopt virtual care in routine practice and can be an opportunity for shared care between people with DM and the team. Several members of the multidisciplinary DM team can meet for videoconference, make collaborative decisions with patients, in order to result in more effective, safer and quality care[36].

Among the studies that address the care of people with 2DM, there are those with foot injuries, in facing the challenges posed by the pandemic[18,19]. Given this scenario, it is important that health services focus on the triad of care for people with diabetic foot ulcers: (1) keep these users out of hospitals in order to reduce exposure to risk and not overload the health system; (2) ensure the conditions so that care is guaranteed at home, considering an intervention plan that goes beyond the offer of medication, also contemplating food, functional, psychological and self-care aspects; and (3) provide security, in order to enable the good evolution of these individuals[37].

Moreover, more than half of the selected studies reveal that remote monitoring, with the help of integrated web platforms, is an important tool to ensure the glycemic range at an adequate level among children, adolescents and young adults with 1DM[15,17–18,21–22,25–26,29–31,33–34]. Accordingly, a prospective observational study showed that structured virtual visits adequately maintain preexisting glycemic management or improve time in the target range among individuals with 1DM during an emergency, when one-to-one consultations are not allowed[35].

The technology is known to have become essential during the COVID-19 pandemic. In times of isolation and social distance, the world trusted technology to learn, live and stay

connected. Technology is best used to leverage and maintain children's social, physical, emotional, intellectual and spiritual well-being in an environment where children are engaged with an adult[38]. In this scenario, it is essential that family members or caregivers are involved in DM care plans, especially for the public of children and adolescents, who need family supervision and support to deal with technological innovations.

Mobile cell phone technologies, which carry clinical and glycemic data, proved useful during the pandemic and in remote care for women with GDM[12,20]. Furthermore, data from a series of cases stated that the use of gestational telediabetology aided with glucometers synchronized to cell phones stores data in the cloud for professionals to access, which can be considered in the management of hyperglycemia in pregnancy in the current scenario. Although it has advantages and disadvantages, telehealth for GDM management can be a useful tool in selected situations, in which patients are asymptomatic and clinically stable. More research is needed to study the benefits, risks, and care outcomes of gestational telediabetology[39].

In the current decade, great efforts have been made to change the glucose detection system to internal monitoring and remote management of patients with DM[40]. To prevent the risk of coronavirus transmission, remote monitoring of glucose levels is necessary to provide personalized home care. Thus, the development of continuous personalized glucose monitoring attracted more attention during this pandemic to efficiently manage DM and prevent the spread of the coronavirus[41]. These results may attract the attention of healthcare professionals to explore not only continuous glucose monitoring devices, but also accurate and reliable continuous subcutaneous insulin infusion systems (pumps), which can stimulate patient compliance, seeking better DM management during the pandemic.

Therefore, in the context of these unprecedented times, the intervention of telemedicine, in support of continuous glucose monitoring, would be an ideal solution for DM management, which enables remote clinical consultation for patients with DM via glucose self-monitoring supported by personalized continuous glucose monitoring devices, not only favoring efficacy in DM treatment, but limiting exposure to the coronavirus among patients and professionals to contribute to global efforts against the coronavirus[40]. This review highlights current trends over the course of the pandemic period in terms of glucose measurement using different non-invasive techniques for real-time and/or archive glucose monitoring[17–18,22,25,31,32–34].

Continuous glucose monitoring, which includes accurately tracking fluctuations in blood glucose levels without increasing the risk of exposure to coronavirus, it becomes an important strategy for DM self-management during the course of the pandemic, efficiently contributing to DM treatment and combating COVID-19[40]. Furthermore, it is necessary that training on the use of pumps, sensors and carbohydrate counting be scheduled with specialists, including nutritionists and/or nurses. Thus, the educational role of virtual assistance is enhanced and access to technologies is favored despite the physical distance[42].

It is also considered what critical and lasting consequence of the pandemic will be the accelerated adoption of digital technology in health care provision. In this context, it is found that DM care is an excellent example of the confluence of the pandemic and the growing importance of technology to transform care delivery and maximize results, despite the macro challenges[43].

Given the above, it can be inferred that the technological revolution in the health area is a great ally for treatment of people with chronic conditions. It was observed, in general, that the use of technologies for the care of people with DM was enhanced in response to the new coronavirus pandemic. Health institutions had to innovate and manage the monitoring of people with DM, there is a growing expansion of new technologies available that, until recently, was not even thought to exist and are currently considered essential tools for DM self-care.

It is understood as limitations of this scoping review the fact that the onset of the pandemic and the intense flow of information on the subject hinder the availability of stable recommendations. The presence of studies without a robust methodological content increases the risk of information bias. In addition to this, choosing to select studies only on the first ten pages of Google Scholar has the possibility of omitting potentially relevant documents.

With the set of information highlighted in this study, it is expected to contribute to the construction of knowledge about technologies combined with DM treatment in times of the COVID-19 pandemic. As discussed, emerging changes in the universe are bearing fruit in the context of health, where the growing reliance on technology to provide care during a pandemic is transforming traditional ways of providing care and will likely result in a positive model of remote consultation, where appropriate, in the new post-pandemic world. The aim is also to encourage the scientific community to develop new studies, aiming at better understanding the applicability of digital technologies in DM, as well as assessing and increasing it from studies with a robust methodological design.

CONCLUSION

Telehealth, monitoring technologies, insulin delivery systems and communication devices were tools used to follow-up DM patients during the COVID-19 pandemic. Digital technologies were used in the care of people with severe DM during the COVID-19 pandemic. It is expected that this evolution will persist in the post-pandemic period, for monitoring and managing DM, in person or remotely, aiming at improving and continuing care for this disease.

RESUMO

Objetivo: Mapear as evidências sobre a utilização de tecnologias digitais no cuidado a pessoas com diabetes durante a pandemia de COVID-19. **Método:** Revisão de escopo, fundamentada no manual do JBI, que incluiu artigos científicos e literatura cinza oriunda de nove bancos de dados primários e sete secundários. Os artigos foram avaliados de forma independente por dois revisores. Utilizou-se o Rayyan® para seleção dos estudos. A descrição da caracterização dos estudos se encontra apresentada em tabela e quadros, findando em síntese narrativa.

Resultados: Identificaram-se 1.964 estudos e, após seleção, restaram 23 publicações para análise. Revelou-se que a telemedicina foi utilizada em todos os estudos e as tecnologias de apoio à consulta remotas incluíam dispositivos de monitoramento de glicose contínuo, *software* de análise de dados de glicose, sistemas de aplicação de insulina, aplicativos, aparelhos de comunicação áudio e/ou voz, que facilitaram o acompanhamento e o gerenciamento remoto do diabetes mellitus. **Conclusão:** Telessaúde, tecnologias de monitoramento, sistemas de aplicação de insulina e aparelhos de comunicação foram ferramentas utilizadas para o acompanhamento dos pacientes com diabetes durante a pandemia.

DESCRITORES

Tecnologia; Tecnologia Educacional; Aplicativos Móveis; Infecções por Coronavírus; Síndrome Respiratória Aguda Grave; Diabetes Mellitus.

RESUMEN

Objetivo: Mapear la evidencia sobre el uso de tecnologías digitales en la atención de personas con diabetes durante la pandemia de COVID-19. **Método:** Revisión del alcance, basada en el manual del JBI, que incluyó artículos científicos y literatura gris de nueve bases de datos primarias y siete secundarias. Los artículos fueron evaluados de forma independiente por dos revisores. Se utilizó Rayyan® para la selección de estudios. La descripción de la caracterización de los estudios se presenta en tabla y tablas, finalizando en una síntesis narrativa. **Resultados:** Se identificaron 1.964 estudios y, tras la selección, quedaron 23 publicaciones para análisis. Resultó que la telemedicina se utilizó en todos los estudios y las tecnologías de apoyo a la consulta remota incluyeron dispositivos de monitoreo continuo de glucosa, software de análisis de datos de glucosa, sistemas de administración de insulina, aplicaciones, dispositivos de comunicación de audio y/o voz, que facilitaron el control y el manejo remotos de la diabetes mellitus. **Conclusión:** La telesalud, las tecnologías de monitoreo, los sistemas de administración de insulina y los dispositivos de comunicación fueron herramientas utilizadas para monitorear a los pacientes con diabetes durante la pandemia.

DESCRIPTORES

Tecnología; Tecnología Educacional; Aplicaciones Móviles; Infecciones por Coronavirus; Síndrome Respiratorio Agudo Severo; Diabetes Mellitus.

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