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MOBILE APPLICATION RESOURCES TO SELFCARE AND SELFMANAGEMENT OF TYPE I DIABETES MELLITUS: INTEGRATIVE REVIEW

Recursos de aplicativos móveis para autocuidado e autogerenciamento do diabetes mellitus tipo i: revisão integrativa

Recursos de aplicaciones móviles para el cuidado automático y el autogestión de la diabetes mellitus tipo i: revisión integrativa

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ABSTRACT

Objective: To identify available resources in móbile applications that favor selfcare and selfmanagement of Type I Diabetes Mellitus. **Methods: i**t is an integrative review developed on databases: BVS, PUBMED and Scopus, with the descriptors: Diabetes Mellitus AND Mobile applications in Portuguese, Spanish and English. **Results:** 16 articles were analyzed and we identified in them the main resources for selfcare and selfmanagement of Type I Diabetes Mellitus: glucometer, digital diabetes diary, glucose corrective actions, food control and communication between user and health professional and user with their peers. **Conclusions:** there was a scarcity of studies whose target audience is people living with type I Diabetes Mellitus. Results indicate that the resources identified in the mobile device applications help individuals with type I Diabetes Mellitus in self-care and self-management of the disease.

Descriptors: Type I Diabetes mellitus, Technology, Mobile apps, Nursing, Chronic disease.

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RESUMO

Objetivo: Identificar os recursos disponíveis em aplicativos móveis que favoreçam o autocuidado e o autogerenciamento do Diabetes *Mellitus* tipo I. **Métodos:** trata-se de uma revisão integrativa realizada nas bases de dados: BVS, PubMed e Scopus, com os descritores Diabetes *Mellitus* AND Aplicativos móveis, nos idiomas português, espanhol e inglês. **Resultados:** foram analisados 16 artigos e neles identificados os principais recursos para o autocuidado e o autogerenciamento do Diabetes Mellitus tipo I: glicosímetro, diário digital de diabetes, ações corretivas de glicose, controle alimentar e comunicação entre usuário e profissional de saúde e usuário com seus pares. **Conclusões:** evidenciou-se a escassez de estudos cujo público alvo são pessoas que convivem com Diabetes *Mellitus* tipo I. Os resultados indicam que os recursos identificados nos aplicativos para dispositivos móveis auxiliam os indivíduos com Diabetes *Mellitus* tipo I no autocuidado e autogerenciamento da doença.

Descritores: Diabetes mellitus tipo I, Tecnologia, Aplicativos móveis, Enfermagem, Doença crônica.

RESUMEN

Objetivo: Identificar los recursos disponibles en aplicaciones móviles que favorecen el autocuidado y el autocontrol de la diabetes mellitus tipo I. **Métodos:** Esta es una revisión integradora realizada en las bases de datos: BVS, PUBMED y Scopus, con los descriptores Diabetes Mellitus y aplicaciones móviles, en portugués, español e inglés. **Resultados:** Se analizaron 16 artículos e identificaron en ellos los principales recursos para el autocuidado y el autocontrol de la diabetes mellitus tipo I: glucómetro, diario digital de diabetes, acciones correctivas de glucosa, control de alimentos y comunicación entre usuarios y profesionales de la salud y usuarios con sus pares. **Conclusión:** se evidenció la escasez de estudios, cuyo público objetivo son las personas que viven con Diabetes Mellitus tipo I. Los resultados indican que los recursos identificados en las aplicaciones de dispositivos móviles ayudan a las personas con Diabetes Mellitus tipo I en el autocuidado y autocontrol de la enfermedad

Descriptores: Diabetes mellitus tipo I, Tecnología, Aplicaciones móviles, Enfermería, Enfermedad crónica.

INTRODUCTION

The development of Information and Communication Technologies (ICTs) is growing in the health field, including nursing, then representing an excellent didactic strategy that favors the organization of the teaching-learning process and increases safety in caring practices.[1]

ICTs have several data processing tools that allow the user of the health system to store and view data, which can be shared with other professionals involved in the assistance, thus helping to make the most appropriate clinical decision for users, as well as in the improvement of therapeutic procedures and comprehensive care.[2]

The technological innovation with the highest impact on contemporary society has been the popularization of mobile technologies (tablets, smartphones). The advancement in the mobile device market has created new facilities for accessing various applications in its virtual stores. With this, mobile applications, known as Apps - short for Application, contemplate the desired target audience, accompanying its user at all times and everywhere.[3]

Nowadays, there is a wide range of technologies and apps focused on the health area (*m-saúde*/m-health) contributing to the solidification of a new type of assistance. Among the several advantages of apps, the possibility of offering features geared to the needs of users stands out, including people living with chronic diseases.[2,4]

Concerning chronic diseases, it is noteworthy that Brazil ranks 4th among the 10 countries with the highest number of people with Diabetes Mellitus (DM) affecting 16,780,800 Brazilians within the age group from 20 to 79 years old, and 95,846 children and adolescents aged between zero and 19 years old with Type I Diabetes Mellitus (Type I DM).[5]

Given this framework, researches reveal that the apps offer motivation and support for self-management of DM and increasingly seek to explore users' preferences to promote adherence to the tool.[6]

Bearing the aforementioned in mind, it is evident the imminent need for health professionals to insert themselves into the technological environment of apps, to use these features as care tools to facilitate health education, especially for people living with DM. Hence, this work meant to identify available mobile application features that favor self-care and self-management of Type I Diabetes Mellitus.

METHODS

It is an integrative literature review, which was carried out according to a protocol[7] that includes the following steps: 1) defining the research team; 2) identification of the research question; 3) protocol assessment; 4) both selection and extraction of studies; 5) validation of the selection process for the included studies; 6) both assessment and evaluation of the included studies; 7) both analysis and interpretation of the results.[7]

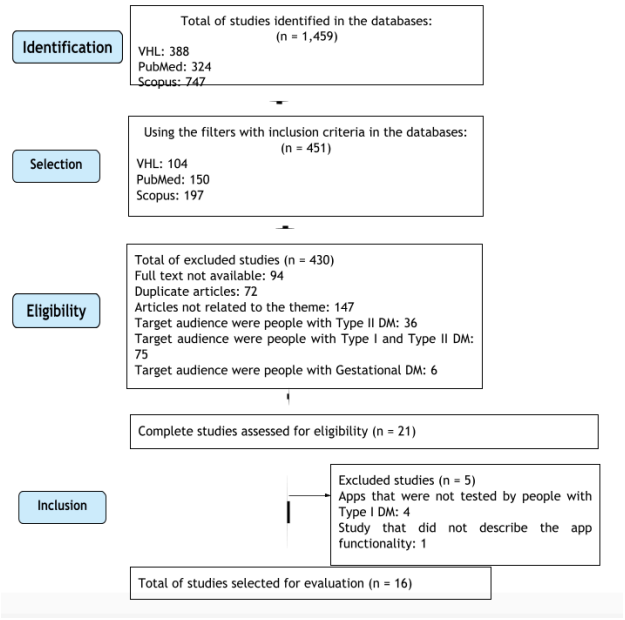
The team was comprised by one undergraduate student, one MSc student, and two professors (PhD). The research question was elaborated based on the PICO strategy (Population, Intervention, Conduct, Outcome) "What are the available mobile application features aimed at individuals with Type I DM, which are able to assist in the disease's self-care and self-management?".

The inclusion criteria were as follows: studies published in the last 10 years (from January 2009 to June 2019), time frame defined by the advancement of the development of applications in the health area in this period, available in full online; in Portuguese, English, and Spanish; published and indexed in the Virtual Health Library (VHL), PubMed and Scopus databases; articles that focused on applications designed and tested by individuals diagnosed with Type I DM. Duplicate articles were excluded.

The search was carried out by two members of the research team over the period from May to June 2019. A cross between the descriptors was used, with the Boolean operator "AND". In English, Diabetes Mellitus AND

mobile applications; in Portuguese, Diabetes Mellitus AND *aplicativos móveis*; and Spanish, Diabetes Mellitus AND *dispositivos móviles*. In compliance with the inclusion and exclusion criteria, 16 articles were chosen and included in the sample, according to the flowchart constructed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA)[8] (**Figure 1**).

Figure 1- Flowchart of the study selection process using the PRISMA methodology. Chapecó city, Santa Catarina State, Brazil, 2019



After selecting the articles, each of them was read in full and critically and filled out the protocol[7] to scrutinize the data and extract the information to answer the study's objective.

RESULTS AND DISCUSSION

There were analyzed 16 articles, 12 from the PubMed database; three from Scopus; and one from the VHL.

The 16 (100%) articles were published in international journals, in the English language; no publications in Spanish and Portuguese were selected for evaluation. In regard to the countries where the studies were developed and published, there was the following distribution: United States of America (USA) eight (50%), Canada four (25%), Switzerland two (12.5%), England one (6.25%), Germany one (6.25%). Given these data, it is possible to evidence the lack of studies addressing apps for people who live with Type I DM.

According to the publication year, the following data was obtained: 2015 five (31.25%); 2017 four (25%), 2018 four (25%); 2013 one (6.25%), 2014 one (6.25%) and 2016 one (6.25%) article.

Concerning the assessment of the level of evidence, the studies were classified as Level I: evidence from systematic review or meta-analysis, randomized controlled clinical trials or from clinical guidelines based on systematic reviews of randomized controlled clinical trials; Level II: evidence derived from at least one well-designed randomized controlled clinical trial; Level III: evidence obtained from well-designed clinical trials without randomization; Level IV: evidence from well-designed cohort and case-control studies; Level V: evidence from a systematic review of descriptive and qualitative studies; Level VI: evidence derived from a single descriptive or qualitative study; Level VII: evidence from the opinion of authorities and/or expert committee reports. Level I: Evidence of a systematic review or meta-analysis of all relevant randomized controlled clinical trials.[9]

Seven studies were classified with the level of evidence VI, six with level II, two with level IV, and one with level III (**Table 1**).

Table 1 - Identification of the studies included in the integrative review. Chapecó city, Santa Catarina State, Brazil, 2019

Title	Authors Publication year and country	Language	Journal	Study type	Level of evidence
PUBMED					
A Mobile App for Synchronizing Glucometer Data: Impact on Adherence and Glycemic Control Among Youths With Type 1 Diabetes in Routine Care.[10]	Mark A. Clements; Vincent S. Staggs. 2017 USA	English	Journal of Diabetes Science and Technology	Retrospective cohort study	Level IV
A Mobile App for the Self-Management of Type 1 Diabetes Among Adolescents: A Randomized Controlled Trial.[11]	Shivani Goyala; Caitlin A Nunn; Michael Rotondi; Amy B Couperthwaite; Angelo Simone; Debra K Katzman; Joseph A Cafazzo; Mark R Palmert. 2017 Canada	English	JMIR Mhealth Uhealth	Randomized clinical trial	Level II
A Pilot Randomized Trial of Text-Messaging for Symptom Awareness and Diabetes Knowledge in Adolescents With Type 1 Diabetes.[12]	Yi Han, Melissa Spezia Faulkner, Heather Fritz, MSN, Doris Fadoju, Andrew Muir, Gregory D. Abowd, Lauren Chefe, Rosa I. Arriaga. 2015 USA	English	Journal of Pediatric Nursing	Randomized controlled pilot study	Level II
Accuracy of Automatic Carbohydrate, Protein, Fat and Calorie Counting Based on Voice Descriptions of Meals in People with Type 1 Diabetes.[13]	Piotr Ladyzynski; Janusz Krzymien; Piotr Foltynski Monika Rachuta; Barbara Bonalska. 2018 Switzerland	English	Nutrients	Cross-sectional observational study	Level VI
Decision Support in Diabetes Care: The Challenge of Supporting Patients in Their Daily Living Using a Mobile Glucose Predictor.[14]	Carmen Pérez-Gandía; Gema García-Sáez; David Subías; Agustín Rodríguez-Herrero; Enrique J. Gómez; Mercedes Rigla; M. Elena Hernando. 2018 USA	English	Journal of Diabetes Science and Technology	Randomized cross-sectional pilot study	Level II
Development of a Smartphone Application to Capture Carbohydrate, Lipid, and Protein Contents of Daily Food: Need for Integration in Artificial	Omar Diouri; Jerome Place; Magali Traverso; Vera Georgescu; Marie-Christine Picot; Eric Renard. 2015 USA	English	Journal of Diabetes Science and Technology	Cross-sectional observational study	Level VI

Pancreas for Patients With Type 1 Diabetes?[15]					
Diabetes Self-Management Smartphone Application for Adults With Type 1 Diabetes.[16]	Morwenna Kirwan; Corneel Vandelanotte; Andrew Fenning; Mitch J Duncan 2013 Germany	English	Journal of Medical Internet Research	Randomized controlled clinical trial	Level II
Exploration of Users' Perspectives and Needs and Design of a Type 1 Diabetes Management Mobile App.[17]	Yiyu Zhang, MMed; Xia Li; Shuoming Luo; Chaoyuan Liu; Fang Liu; Zhiguang Zhou 2018 Canada	English	JMIR Mhealth Uhealth	Qualitative and quantitative study	Level VI
Glucose Control, Disease Burden, and Educational Gaps in People With Type 1 Diabetes.[18]	Cornelis J Tack,; Gerardus J Lancee; Barend Heeren; Lucien JLPG Engelen, Sandra Hendriks; Lisa Zimmerman; Daniele De Massari; Marleen MHJ van Gelder; Tom H van de Belt. 2018 Canada	English	JMIR Diabetes	Cross-sectional observational study	Level VI
Integrating Visual Dietary Documentation in Mobile-Phone-Based Self-Management Application for Adolescents With Type 1 Diabetes.[19]	Dag Helge Frøisland; Eirik Årsand 2015 USA	English	Journal of Diabetes Science and Technology	Qualitative study	Level VI
Qualitative assessment of user experiences of a novel smart phone application designed to support flexible intensive insulin therapy in type 1 diabetes.[20]	Brigid A. Knight; H. David McIntyre; Ingrid J. Hickman; Marina Noud 2016 United Kingdom/England	English	BMC Medical Informatics and Decision Making	Qualitative study	Level VI
Training of Carbohydrate Estimation for People with Diabetes Using Mobile Augmented Reality.[21]	Michael Domhardt; Martin Tiefengrabner; Radomir Dinic; Ulrike Fötschl; Gertie J. Oostingh ; Thomas Stütz; Lars Stechemesser; Raimund Weitgasser; Simon W. Ginzinger 2015 USA	English	Journal of Diabetes Science and Technology	Experimental pilot study	Level III
SCOPUS					
Impact of Information Technology on the Therapy of Type-1 Diabetes.[22]	Rolf-Dietrich Berndt; Claude Takenga; Petra Preik; Sebastian Kuehn; Luise Berndt; Herbert Mayer; Alexander Kaps; Ralf Schiel 2014 Switzerland	English	Journal of personalized medicine	Randomized controlled study	Level II
The First Use of *Bolus* Calculator With Speech Analyzer: The Patients' Perspective.[23]	Karolina Mazurczak, BA; Ewa Pańkowska, Piotr Ładyżyński; Piotr Ładyżyński; Piotr Foltyński 2017 USA	English	Journal of Diabetes Science and Technology	Qualitative study	Level VI
The Effects of a Mobile Phone Application on Quality of Life in Patients With Type 1 Diabetes *Mellitus*.[24]	Iefke Drion; Loes R. Pameijer; Peter R. van Dijk; Klaas H. Groenier; Nanne Kleefstra; Henk JG Bilo. 2015 USA	English	Journal of Diabetes Science and Technology	Randomized controlled clinical trial	Level II
VHL					
Imporved A1C Levels in type 1 diabetes with Smartphone app use.[25]	Edmond Ryan, Joanna Holland; Eleni Stroulia; Blerina Bazelli; Stephanie A. Babwik; Haipeng Li; Peter Senior; Russ Greiner 2017 Canada	English	Canadion Journal of diabetes	Prospective cohort study	Level IV

All articles describe apps targeted and tested by people who live with Type I DM. As for the target audience, five apps were designed to teenagers, six for adults, six for individuals of all age groups, and two articles describe apps for individuals within the age group from three and 69 years old.

Concerning the features of the apps described in the analyzed studies, the following can be highlighted: Glucometer[10,11]; data transmission via Bluetooth[11]; Text messaging system[12,16,22]; automatic speech recognition describing the meal and voice transcription in text[13]; evaluation of the textual description to determine the composition of the meal[13]; insulin dose calculator[13,14,18,20,23]; carbohydrate intake and count[14,15,18]; connection with a telemedicine platform to allow remote supervision by endocrinologists in the hospital[14]; communication with healthcare providers[17,18,22]; diabetes diary[15,17,18,20,21,24,25] (blood glucose records, insulin, diet, exercise, medication, insulin doses, mood); diabetes education[17]; peer communication[17,18]; reminders and/or alarms[17,18]; graphics[18]; access to the smartphone camera to capture the users' real diet[19]; production of reports[20] and database platform in several languages.[22]

The most diverse digital features have been used to help people diagnosed with Type I DM to live with the disease, among them self-monitoring of glucose levels records in digital diaries, favoring self-care and self-monitoring of blood glucose, an essential measure of treatment adherence. Furthermore, self-management aims to involve patients in their long-term care, enabling them to improve the effectiveness of their actions.[10,11]

The daily monitoring of glucose dosage has a positive effect on the patient's life and can improve his glycemic control.[14] The need to monitor glycemic levels represents a fundamental strategy for users to achieve the desired glycemic goals.[26]

Studies[12,16] indicate trends towards the improvement of personal satisfaction and better metabolic control of Type I DM through the use of applications that can send text messages between the person living with Type I DM and the health professional. This action improves the identification of symptoms, the general management of diabetes, and improves monitoring support, significantly improving glycemic control between routine medical follow-up visits.

Still concerning metabolic control, people with Type I DM, despite numerous information provided by health professionals and the media, face several difficulties in adjusting the insulin dose based on their estimates of the calculation of carbohydrate consumption, proteins, and fats at meals.[27] Thus, a system that automatically calculates prandial insulin doses allows bolus insulin to be safely administered.[13,15,16] In this regard, users of DM apps, positively score the usefulness and feature functionality that helps count carbohydrates, providing more accurate estimates of insulin dosage at each meal.[21,23] Overall, users

are pleased and trust the bolus calculator to manage their glucose level.[20]

The use of an app that assists in Type I DM self-care and self-management obtained high levels of satisfaction among its users and medical staff,[21] resulting in a positive impact of glycemic control. Moreover, a study[14] reveals that users' confidence when using apps had a positive subjective assessment of their use. Another study[28] underlines that the carbohydrate counter, blood glucose, and physical activity tracking are app features most commonly preferred by people who live with Type I DM.

Reminders via text messages, SMS (Short Message Service), or automatic phone notifications about medicines and appointments are functions that favor the education and management of the Type I DM, as they increase the frequency of self-care behaviors in people who live with the disease and improve health outcomes for those who needed regular care and monitoring, in addition to care management.[29,30]

Likewise, a study[2] reinforces the effectiveness of text message reminders in cell phones, reminding routine consultations, then resulting in increased compliance.

People living with Type I DM define the use of an app with a digital diabetes diary as easy and friendly,[24] as it allows the user to record essential information for self-management of chronic disease, through features that allow access to the user's personalized screens, buttons shortcut for data entry and food database and calculator connectivity in bolus insulin dose.[20] Also, the records benefit the clinical tracing and are associated with improved blood glucose regulation.[25]

Exploring the needs and perspectives of users vis-à-vis the features and design present in an app for Type I DM management is essential to provide meaningful guidance in planning and designing applications that are effective and satisfying for those who use it.[17]

A survey carried out in England[31] showed that people living with Type I DM express a desire for an application including features that include visual functions such as charts, videos, games, questionnaires, and comparative functions that allow identifying the effect of food on glycemic control. This same study points to digital communication between peers as positive, since sharing experiences motivates them to share their struggles and change their habits.[31]

The app has the potential to improve diabetes self-management by providing personalized educational support, which helps people living with diabetes to understand the basics of their disease and thereby empower them and assist them in defining and dealing with treatment challenges and also benefit from DM control.[18,19]

Nonetheless, to be an effective tool for self-care and self-management, the app must continuously capture users' attention and stimulate interest in technology. Engagement should be based on the ultimate goal of using apps for people living with chronic diseases, in other words, promoting their effective participation in self-care activities.[6]

CONCLUSIONS

The Type I DM is a chronic disease with an upward trend of cases, then representing one of the main public health issues. Even with so much information addressing its caring practices, there is still difficulties to be faced in Type I DM self-care and self-management. In this respect, the use of digital technologies, especially apps, has been presented as an important tool to help people live better.

It is observed that every day the apps have more improved features, incorporating numerous features. Among the main features identified in the apps aimed at people with Type I DM, there are a glucometer (glycemic control); digital diabetes diary (medication, physical activity, mood, meals); corrective actions (adjustment of glucose levels, an insulin bolus calculator, a record of insulin administration, a reminder of either hyperglycemia or hypoglycemia); food control (counter of carbohydrates, proteins, and fats ingested); and communication between users and health professionals, as well as users and their peers.

Nevertheless, despite the relevance of this theme, it is clear that there are few studies addressing the subject, especially in Brazil, then corroborating the need to develop new research and, especially, new apps that incorporate the features discussed here as important tools for Type I DM self-care and self-management.

Herein, it is suggested that further studies should be performed, deepened, and disseminated in both technology and nursing research fields. Bearing in mind the above-mentioned, this work might support other studies to obtain elements for the development of applications toward people living with Type I DM.

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