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Original Article

Evidence of the content validity of an app on the oral health of elderly people with diabetes mellitus*

Evidências de validade de conteúdo de aplicativo sobre saúde oral de idosos com diabetes mellitus

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ABSTRACT

Objective: to verify the evidence of content validity of the app with the theme of oral health and diabetes mellitus in the elderly. **Methods:** technological development study of an app, based on Systemic Instructional Design and implemented using the React Native framework, using the JavaScript programming language and the React library. It was validated by 19 expert judges and then evaluated by 19 elderly people. The criterion for content validation agreement was 95%, as analyzed using the Content Validation Index, and suggested adjustments were made accordingly. **Results**: a Content Validation Index was obtained, with averages of 0.94 by the expert judges, 0.98 by the older participants, and 0.95 overall for the assessed items, indicating that it was recognized as relevant and accessible. **Conclusion**: the application was developed, and, according to experts and the elderly, it demonstrates evidence of content validity, with high scores obtained for this measure, fully confirming its applicability and relevance. **Contributions to practice**: the use of mobile applications as a tool for educating the elderly about oral health can encourage greater self-care and awareness of its importance in the management and control of diabetes mellitus. **Descriptors**: Aged; Technology; Mobile Applications; Oral Health; Diabetes Mellitus.

RESUMO

Objetivo: verificar as evidências de validade de conteúdo do aplicativo com a temática saúde oral e diabetes mellitus em pacientes idosos. **Métodos:** estudo de desenvolvimento tecnológico de aplicativo, a partir do *Design* Instrucional Sistêmico e implementado por meio do *framework React Native*, utilizando a linguagem de programação *JavaScript* e a biblioteca *React*. Foi validado por 19 juízes especialistas e avaliado posteriormente por 19 pessoas idosas. O critério para validação de conteúdo foi de 95%, analisada por meio do Índice de Validação de Conteúdo, sendo realizados os ajustes sugeridos. **Resultados**: obteve-se Índice de Validação de Conteúdo com médias de 0,94 pelos juízes especialistas, 0,98 pelos idosos e 0,95 no geral nos itens avaliados, sendo reconhecido como relevante e acessível. **Conclusão**: o aplicativo foi desenvolvido e, segundo especialistas e idosos, apresenta evidências de validade de conteúdo, com altos índices obtidos para essa medida, confirmando plenamente sua aplicabilidade e relevância. **Contribuições para a prática**: a utilização de aplicativos móveis como ferramenta de educação para o público de pessoas idosas na saúde oral pode fomentar maior autocuidado e conscientização sobre a importância desta no manejo e controle do Diabetes Mellitus. **Descritores**: Idoso; Tecnologia; Aplicativos Móveis; Saúde Bucal; Diabetes Mellitus.

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Introduction

Diabetes Mellitus (DM) is a multifactorial disease of origin, which can be congenital or acquired, and is characterized by a high concentration of glucose in the blood. Worldwide, 537 million adults live with diabetes, 50% of whom are undiagnosed. It is estimated that this number will rise to 783 million by 2045, representing an increase of approximately 46%[1]. Brazil ranks 5th in the world, with around 20 million people with the disease, behind only China, India, the United States, and Pakistan[2-3].

The association between DM and oral diseases has been recognized since the 1980s, with oral manifestations such as periodontal disease, reduced salivation, xerostomia, burning mouth, changes in taste, tooth loss, and poor healing. Scientific evidence indicates that treating periodontitis can significantly reduce glycated hemoglobin levels in people with type 2 diabetes[4].

Low adherence to self-care is considered one of the factors contributing to the increased incidence of DM. In this context, health education and encouraging self-care are essential strategies for preventing complications and promoting long-term health[5]. Successful treatment of the disease depends on the patient's ability to self-monitor their blood glucose, becoming the protagonist of their own care in various spheres, including health promotion, prevention, disease control, self-medication, and rehabilitation[6].

The Consensus Report of the European Association for the Study of Diabetes and the Diabetes Technology Working Group seeks strategies to prevent and improve the quality of life of people with DM, primarily through health technologies. However, guidelines and regulations must be adopted for their use[7]. With the growth of the older population and technological advances, apps have emerged to promote physical, emotional, and psychological well-being, thereby supporting active and healthy aging[8].

M-health (mobile health) refers to the use of mobile technologies to prevent, diagnose, and monitor disease[9]. It is therefore essential to develop apps that are accessible to the elderly, respecting their physical, cognitive, and emotional characteristics[10].

In Brazil, oral health apps are primarily designed to manage dental services for children[11]. Apps for people with diabetes focus on glycemic control, insulin monitoring, carbohydrate counting, and diabetic foot risk, such as the "Carbohydrate Counting", "Diabetes Play", "Sisped", "SBD 2024 Guideline", and "Retina Risk" apps, recommended by the Brazilian Diabetes Society[12].

However, no specific apps for oral manifestations in the elderly with DM were found until January 2025. This highlights a gap in the literature and digital practice aimed at oral healthcare for the elderly with diabetes. This study aimed to verify the evidence of content validity of the app with the theme of oral health and diabetes mellitus in the elderly.

Methods

Type of study

This is a technology development study based on Contextualized Instructional Design, used to plan and develop interventions, consisting of four stages: analysis, design, implementation, and evaluation[13]. This framework served as the basis for creating and evaluating the content validity of a mobile application designed for older adults, their caregivers, family members, and healthcare professionals.

Study protocol

The development of the application was divided into four stages. The first was a bibliometric analysis of oral cavity care in the elderly with diabetes. The R Bibliometrix library was used to refine the research and facilitate the identification of trends and their impact on scientific production[14-15]. R Bibliometrix is widely used for bibliometric analysis, with a primary focus on the Web of Science and SCOPUS, offering robust and direct support for importing data, which justifies the choice of these databases. The following Health Scien-

ces Descriptors (DeCS) and Medical Subject Headings (MeSH) were used: Aged, Elderly, Technology, Mobile Applications, Oral Manifestation, Dental Care for the Elderly, Diabetes Mellitus.

The guiding questions were: How has collaboration between health, self-care, diabetes mellitus (DM), the elderly, and technology been addressed in scientific literature in terms of frequency of publication, types of study, and geographical areas? What are the main trends, gaps, and opportunities for research in this area?

This previously published study concluded that there has been a significant increase in publications on the subject, and that dentistry should participate in the development of applications that address the oral health of the elderly with diabetes[14].

Following this survey, the team discussed the content, target audience, and other project stages. The development of the Oral DM Plus app was based on the initial prototype of the Oral DM app, which was previously developed as part of a Scientific Initiation Project in June 2023. The development was structured into three phases: pre-production, production, and post-production.

In the pre-production phase, content was selected based on scientific evidence, national and international guidelines on diabetes mellitus, and mobile applications in healthcare as of 2020.

The second stage of the study involved developing and producing the Oral DM Plus app. This process included designing its visual identity, which involved creating a logo and selecting screens, images, and content to be inserted. To ensure the quality of the material, authored videos were produced with a script and scientific content. The text and subtitles of these videos were translated into English, allowing for the dissemination of the information.

The technical development of the Oral DM Plus application was carried out by a computer professional, following a structured flow to ensure the efficiency and quality of the final product. The React Native framework was used, a Facebook technology that is ideal for creating multi-platform mobile applications (iOS and Android) from a single codebase. Coding was carried out by combining the JavaScript programming language with the React library[16], allowing for agile and modular development of the interface components. Based on the predefined design, the user interface was developed, featuring screens, buttons, and intuitive visual elements to provide a seamless experience. Once the structure was built, the content was integrated, including texts, images, and authored videos with subtitles and translations. Rigorous tests were conducted to identify and correct bugs and glitches, ensuring that all functionalities worked fully, including navigation between screens and video playback, thereby guaranteeing the stability and usability of the application.

The application was enabled for the Android platform. A button for adjusting the font (increase or decrease), clinical images (authorized by signing the Consent Form for Use of Images), and educational videos were inserted, making a total of 26 resources. All the videos were subtitled in Portuguese and English.

The third stage involved analyzing evidence of content validity by expert judges and evaluating the response process through feedback from the target audience (the elderly). Data was collected from the judges in a virtual environment, using Google Forms, WhatsApp, and email, between July and December 2024.

To select the expert judges, contacts were obtained through the Lattes Platform, considering dental surgeons with experience in gerontology and health education. The sampling technique used was snowball sampling[17], a non-probabilistic and qualitative approach based on the availability of participants. Invitations were sent via email or messaging app, accompanied by explanations of the study's objectives. After acceptance, the material was sent by email.

The inclusion criteria for the judges were an undergraduate degree in dentistry, a master's degree (minimum), specialization in related areas, and experience in teaching, research, and/or clinical practice for at least two years. The exclusion criterion was failure to complete the data collection instrument. Of the

27 invitations sent out, 19 accepted the invitation to participate. Of these, nine were selected using the Lattes curriculum vitae, and 10 were selected using the snowball technique; eight did not answer the questionnaire and were excluded.

The instrument used to collect data from the judges was the "Application Evaluation Protocol," adapted from a previous study[17], with characteristics tailored to this study and prior authorization from the authors. It contained evaluation topics, degree of agreement, relevance, comments, and suggestions. The experts received an invitation letter and the link to the Informed Consent Form via WhatsApp or email. After accepting, they had access to the application link, a demonstration video, and the electronic validation and sociodemographic characterization form.

Location, period, and sample

The research stage, which involved verifying the response process through evaluation by the target audience, was conducted at an institution for the elderly affiliated with the Federal University of Paraíba in João Pessoa, Brazil, from July to December 2024.

Regarding the target audience sample, the inclusion criteria were being aged 60 or older and participating in the activities of the Instituto Paraibano de Envelhecimento (Paraibano Institute of Aging), affiliated with the Federal University of Paraíba. Of the 435 elderly registered, 20 were randomly selected, forming a non-probabilistic convenience sample, as determined by the team. Of these, 19 participants agreed to take part, and the evaluation was conducted in person in July 2024 at the Institute, where the application was presented along with its features and objectives.

Data collection

The collection instrument used with the elderly was the "Application Evaluation Form for the Elderly," adapted from a previous study[18] according to the characteristics of this study and with the prior authorization of the authors, with the following topics: evaluation of objectives, structure, presentation, and degree of relevance, as well as space for comments and suggestions. Participants also completed a sociodemographic questionnaire, which was administered with the researchers› support. The exclusion criterion was failure to complete the forms.

After expert judges had analyzed the evidence of content validity and the response process of the target audience, the elderly, final adjustments were made in the post-production phase.

Data analysis and processing

The degree of agreement/relevance between the experts/elderly people on the technology was assessed using the Content Validity Index (CVI), which measures the proportion of judges and elderly people who agree with the items in the instrument. The CVI was calculated overall and per item using a Likert scale as follows: in the collection instrument for the elderly (1=inadequate; 2=partially adequate; 3=adequate; and 4=totally adequate), and in the judges' protocol, the nomenclature was (1=irrelevant; 2=partially relevant; 3=relevant; 4=very relevant, and 5=very relevant), ensuring rigor in the evaluation.

The responses were organized in a Microsoft Excel® database and analyzed using descriptive statistics, with the CVI applied using the formula: CVI = Number of responses 3, 4, or 5 / Total number of responses, as only these are considered valid responses. Items 1 (inadequate/irrelevant) and 2 (partially adequate/relevant) are reviewed. It is worth noting that the recommended minimum CVI is 0.78 for individual items (I-CVI) and 0.80 for the total scale (S-CVI), ideally exceeding 0.90[19].

The data were processed using Epi Info software version 7.2.4. The information is self-authored, obtained through the application of collection instruments, and is available on the Mendeley platform[20].

The fourth and final stage consisted of registering the application-type computer program, Oral DM Plus - *Guia de Saúde Bucal ao Paciente Idoso Diabético* (Oral Health Guide for Elderly Diabetic Patients), with

the National Institute of Industrial Property, under number BR512025001758.

Ethical aspects

The study was approved by the Research Ethics Committee of the Health Sciences Center of the Federal University of Paraíba, under opinion no. 6,844,806/2024 and Certificate of Presentation for Ethical Appraisal no. 79436424.9.0000.5188.

Results

The construction of the Oral DM Plus app followed a structured approach, with content carefully selected to meet users' needs. The first phase of development involved a literature review and analysis of guidelines related to oral health and diabetes, which informed the selection of topics. The material was organized into modules, such as "What is diabetes?", "Types of diabetes," and "Diabetes and oral health," to facilitate navigation and promote transparent and accessible learning.

The Oral DM Plus app was developed to inform elderly individuals with diabetes about how to prevent and manage oral lesions, as well as reinforce the importance of self-care and the influence of oral health on diabetes mellitus control.

The app's logo features a stylized name that references the themes of oral health and diabetes and is displayed on the mobile device after installation.

The language is accessible, with short sentences and no technical terms, and the icons and illustrations encourage interactivity and engagement. On the settings screen, users can adjust the font size, which is particularly important for older individuals, and select their preferred language (Portuguese or English). Clicking on the "access" button displays the content of the selected screen (Figure 1), with explanatory text and a corresponding video. The app includes 26 subtitled screens, available exclusively for Android devices at the following link: https://drive.google.com/file/d/1l6sw3FUDXukU6yri2X1oZGCMWDS0QJL5/view?usp=sharing.

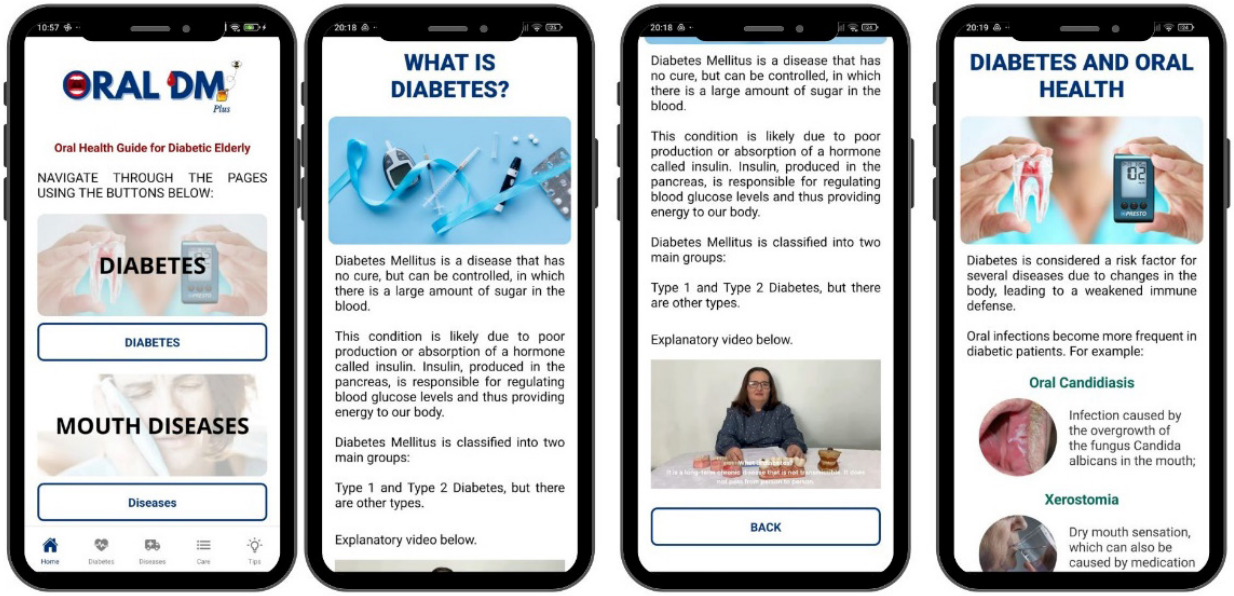

Figure 1 – Screen interface of the Oral DM Plus application. João Pessoa, PB, Brazil, 2024

On the home screen, the first button takes you to the "Diabetes" section, with three subsections: "What is diabetes?", "Types of diabetes," and "Diabetes and oral health," featuring texts in larger font and explanatory videos.

The second button leads to the "Diseases of the

Mouth" section, with eight topics: gingivitis, periodontitis, root caries, hyposalivation, xerostomia, oral candidiasis, halitosis, and oral cancer. Each topic has simple explanations, signs and symptoms, and short videos.

The third button leads to the "Care" section, which includes topics such as mouth hygiene, denture hygiene, diabetes management, and regular dental visits. The "Oral Hygiene" section covers flossing, types of brushes, toothpastes, and tongue cleaning. The fourth button on the home screen leads to the "Tips" tab, with six topics: smoking cessation, harmful habits, family presence, diet, physical exercise, and the Elderly Person's Handbook.

Nineteen expert judges participated in the validation stage, all of whom were dentists; 16 had a doctorate, and 3 had a master's degree. Two participants had a master's degree in gerontology, and the others worked in related fields, providing sample diversity. The sociodemographic data are described in Table 1.

Table 1 – Sociodemographic characterization of the judges (n=19). João Pessoa, PB, Brazil, 2024

Variable	n (%)*
Title	
Master's Degree	3 (15.7)
Doctorate	16 (84.2)
Residence	
Brazil (Northeast: 14, Southeast: 3, Midwest: 1)	18 (94.7)
United States (Illinois, Chicago)	1 (5.2)
Current occupation	
Teaching	9 (47.4)
Assistance	8 (42.0)
Management	1 (5.2)
Research	1 (5.2)
Professional experience	
Oral health promotion	18 (94.7)
Oral health of the elderly	13 (68.4)
Preparation of educational material	17 (89.4)

*Number of participants for each region

Some judges worked in care, teaching, and research, and most had more than 10 years' experience in health education. These data reveal that the participants possess both theoretical and practical qualifications, lending credibility to the evaluations conducted.

The instrument used to verify the evidence of content validity by the experts was the "Application Evaluation Protocol," with a *Likert* scale scored from 1 to 5, (1) irrelevant, (2) partially relevant, (3) relevant, (4) very relevant, and (5) very relevant, in relation to the agreement/relevance of the technology. The overall Content Validation Index (CVI) by the experts was 0.94. See Table 2 below for the main results.

Table 2 – Content validity index referring to the experts' assessment of the agreement and relevance of the Oral DM Plus app (n=19). João Pessoa, PB, Brazil, 2024

Questions	CVI*	
	Concordance	Relevance
Is the content covered in the app sufficient for the care of the oral manifestations of diabetes mellitus in the elderly?	1	1
Is the language used in the app suitable for the target audience?	0.9	0.9
Are the app's illustrations suitable for the target audience?	1	1
Are the illustrations in the app necessary for understanding the content?	0.9	1
Do the topics covered in the sequence in which they are presented in the app motivate the elderly person/reader to understand the proposed theme?	0.9	0.9
Does the proposed content motivate the elderly to change their behavior and attitude?	0.9	0.9
Is the technology (an app with videos) suitable for the target audience?	0.7	0.9
Would you recommend the applicability of the educational app, in its current format, to the routine of health services aimed at the elderly?	0.9	0.9
Total CVI	0.9	0.9

*CVI: Content Validation Index

In the evaluation by the elderly, the initial version of the prototype was presented in person to 19 participants, most of them women (89%), aged between 70 and 79 (60%), with a high level of education, and retired. All lived in the city of João Pessoa.

The "Elderly App Evaluation Form" was used as an instrument, focusing on the objectives, structure, presentation, and relevance of the technology, using a score from 1 to 4, where (1) inadequate, (2) partially adequate, (3) adequate, (4) totally adequate, as described in Table 3.

Table 3 – Elderly people's assessment of the objectives, structure, and presentation of the Oral DM Plus app (n=19). João Pessoa, PB, Brazil, 2024

Questions	CVI*	
	Objectives	Structure
Is the information in the Oral DM Plus app aligned with the characteristics of older adults?	1.0	1.0
Does its use contribute to the quality of life of elderly diabetics?	1.0	1.0
Do you encourage guidance on oral health, cancer prevention, and general tips?	0.9	1.0
Can professionals use it to care for elderly people?	1.0	0.8
Does it meet the objectives of its intended audience?	1.0	1.0
Are the themes coherent with the elderly diabetic population?	0.9	1.0
CVI total	0.9	0.9

*CVI: Content Validation Index

In this study, the process of verifying evidence of content validity was crucial to ensure the credibility of the application, with a high agreement rate: a CVI of 0.94 among expert judges, 0.98 among the elderly, and an overall average of 0.95.

This index was calculated by adding the positive responses (3, 4, and 5) and dividing by the total number of responses. The suggestions received by the experts were incorporated to improve the usability of the tool. We can mention: the content of the texts in the app, using language that is more accessible to the elderly, removing the text on oral cancer self-examination, and adding the information that oral cancer is not related to diabetes, adding details on eating before dental appointments to avoid hypoglycemia.

Discussion

The Oral DM Plus app demonstrated high robustness, exceeding the recommended minimum of 0.90 for health technologies[7-8]. Experts and the target audience validated it to ensure its accuracy, relevance, and suitability for its purpose, especially in chronic disease contexts[17-18,21-22]. This validation is essential to ensure that the materials are efficient, understandable, and meet the needs of this population.

The expert evaluation showed high technical and scientific quality. The sufficiency of the content and the appropriateness of the illustrations saw significant improvements, while the language was evaluated as accessible and effective in communication[4,13-14]. The app was also effective in encouraging the elderly to adopt healthier behaviors, promote self-care, and increase awareness of their health[16-17]. These results validate the rigor in the selection of content and the effort put into visual *design*, which are vital elements for the effectiveness of educational materials[4]. The use of this technology can support the monitoring of health conditions and the adoption of healthy habits, strengthening the autonomy of the elderly.

Only the 'audiovisual resources' item scored lower in the evaluation, due to the suggestion that apps with videos would be more suitable for caregivers, given the resistance of some elderly individuals to this resource. This reflects the impact of digital literacy and sociodemographic factors on the use of technologies by the elderly[5,8].

The evaluation by the elderly confirmed the appropriateness of the app, and the sample was predominantly composed of retired women with higher levels of education. There was total agreement regarding the suitability of the information, its contribution to the quality of life, and fulfillment of the objectives[18-19]. No item was considered inappropriate, even without prior experience using health apps, as it demonstrated intuitive design and accessibility features[2,4-6]. Suggestions to change colors were rejected to

avoid visual conflict, prioritizing usability. This reinforces the potential and relevance of Oral DM Plus in addressing a gap in the literature on apps targeting the oral health of elderly individuals with diabetes[20]. Difficulties in downloading reflected barriers to digital inclusion, highlighting the need for public policies to reduce inequalities[8].

Validation by the target audience strengthens the app's reliability and applicability, as the Likert scale is a consolidated methodology in educational technologies[17-18,23]. The content was based on recommendations from national and international scientific bodies, focusing on prevention and quality of life[1-4,7,12]. Similar strategies, such as the "LPPrev" (prevention of pressure injuries in the elderly) and "Tum-Tum" (for heart failure) apps, have also shown satisfactory evidence of validity and multiprofessional applicability[24-25]. M-Health has proven to be a promising tool in health education, offering accessible and free modalities of care, support for clinical practice, and health management[22,26-28], although the cost of development remains a challenge in Brazil[24].

The "Tum Tum" app has the potential to promote self-care in people with heart failure, just as "LPPrev" showed evidence of superior content validity. It features a self-explanatory interface, reminder-type alarms for decubitus changes and repositioning, information on diet acceptance and fluid consumption, and prompts to fill in details on pressure injury risks, all designed to facilitate individualized care[24-25]. However, a mobile app created to complement the introductory emergency care course was well received by users, but failed to consolidate learning due to technological, linguistic, and content-related difficulties, which acted as limiting factors for effective learning[26].

The development of apps can help in the management of medicines for emergency professionals by providing information on authorship, drug characteristics, and bibliographic references. These elements are fundamental and should be considered to enhance pharmaceutical regulation[27]. The use of mobile applications in pre-hospital care has been studied, and it has been concluded that these devices enhance patient safety and the quality of service provided in pre-hospital emergencies. They also optimize care time and facilitate early diagnosis[28].

The use of educational gerontechnologies, such as booklets, games, workshops, and apps, is effective in engaging families in treatment[10]. However, there is still a need for inclusive apps that include people with disabilities and diabetics[12].

Oral DM Plus has the potential to promote healthy behavior, empower the elderly as active agents of self-care, encourage regular dental appointments, and support family members and caregivers. The high level of agreement among the elderly regarding its use by professionals and the recommendation of specialists shows its applicability and relevance as a health education tool integrated into care. The knowledge gap regarding the relationship between oral health and diabetes is a critical barrier to controlling the disease[29]. Thus, the app was developed to overcome this limitation, featuring accessible language, font adjustments, and the absence of technical terms, thereby promoting preventive attitudes and autonomy among the elderly. The high level of user agreement and the recommendation of specialists confirm the versatility of Oral DM Plus as a comprehensive tool integrated into the routine of health services.

Study limitations

The limitations include the use of the snowball sampling technique, which is a non-probabilistic sampling method. For the bibliometric review, only the SCOPUS and Web of Science databases were used. Additionally, evidence of content validity was only assessed using the Content Validity Index, which may limit the scope of the results. It is also worth noting that the app is currently only available for the Android platform. In addition, translation into Brazilian Sign Language (*Libras, in Portuguese*) was not implemented and should be considered in future stages. Further research is recommended to monitor and evaluate the

impact of using the app on improving oral health and DM control, contributing to health promotion, disease prevention, and improved quality of life.

Contributions to practice

The Oral DM Plus mobile app has the potential to positively impact on the oral health of elderly diabetics, help control the disease, and promote the value of regular dental visits. The tool can be used by elderly people, caregivers, family members, and health professionals to disseminate knowledge on the subject.

It is an original initiative to develop an educational app aimed at the oral health of elderly diabetics. This innovation fills a gap in the field of geriatric dentistry, providing an accessible alternative for information and care at your fingertips.

Conclusion

The Oral DM Plus app was developed, which proved effective in promoting the oral health of elderly people with diabetes mellitus, reinforcing self-care and the patient's active role in managing their health. Experts and the elderly validated the application and showed evidence of content validity. It also indicated that the app aims to raise awareness of the relationship between oral health and diabetes, particularly regarding oral lesions, and the importance of providing relevant information to this audience.

Authors' contribution

Conception and design or analysis and interpretation of data; writing of the manuscript or revision of the intellectual content; final approval of the version to be published; responsibility for all aspects related to accuracy or integrity: Fonsêca MRCP, Dantas CMP, Pereira JO, Mélo CB**.** Drafting of the manuscript or critical review; final approval of the version to be published; responsibility for all aspects of the text in ensuring the accuracy and integrity of any part of the manuscript: Pinho RCM, Silva SPC, Piagge CSLD.

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