Educational apps to support patient safety in hospitals: a technology perspective

Aplicativos de apoio à educação sobre a segurança do paciente hospitalizado: Prospecção tecnológica

Léia Arcanjo Mendes[1]
ORCID: 0000-0001-5535-4728

Clarissa Costa Antunes[1]
ORCID: 0000-0003-3357-5292

Thais Favero Alves[2]
ORCID: 0000-0003-3246-8014

Bruna Figueiredo Manzo[1]
ORCID: 0000-0003-0064-9961

[1]Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil
[2]University of Nebraska Medical Center, Omaha, NE, United States

Editors:
Ana Carla Dantas Cavalcanti
ORCID: 0000-0003-3531-4694

Paula Vanessa Peclat Flores
ORCID: 0000-0002-9726-5229

Corresponding author:
Léia Arcanjo Mendes
E-mail: leia.a.mendes@hotmail.com

ABSTRACT

Objective: To examine mobile applications developed to guide healthcare professionals, patients, and their caregivers regarding patient safety interventions in the context of hospitalization. **Methods:** A technological prospection was conducted in the virtual stores App Store and Google Play and through the Google search tool. Inclusion criteria included applications focused on patient safety in the context of hospitalization without temporal limitations. **Results:** 25 applications were included in the study and analyzed. The Most applications were mobile, developed in English, and focused on healthcare professionals. In addition, they had limitations and weaknesses related to design and playful features. **Conclusions:** The study may contribute to developing of new patient safety education applications that promote increased engagement in error prevention interventions.
Descriptors: Patient Safety; Health Education; Mobile Applications.

RESUMO

Objetivo: Investigar os aplicativos móveis que foram desenvolvidos com a finalidade de orientar os profissionais, os pacientes e seus acompanhantes quanto às ações de segurança do paciente no contexto de hospitalização. **Método:** Prospecção tecnológica realizada nas lojas virtuais *App Store* e *Google Play* e na ferramenta de busca da *Google*, cujo critério de inclusão foi aplicativos voltados para segurança do paciente no contexto hospitalar sem limitação de recorte temporal. **Resultados:** Foram incluídos e analisados no estudo 25 aplicativos. A maioria dos aplicativos eram móveis, desenvolvido em inglês, com ênfase para os profissionais de saúde. Ademais, tiveram como limitação, fragilidades relacionadas ao design e características lúdicas. **Conclusão:** O estudo pode contribuir para desenvolvimento de novos aplicativos para educação sobre a segurança do paciente, promovendo o aumento do engajamento nas ações de prevenção de erros.
Descritores: Segurança do Paciente; Educação em Saúde; Aplicativos Móveis.

INTRODUCTION

Patient safety (PS) is the reduction to an acceptable minimum of the risk of preventable harm associated with healthcare[1]. Adverse events (AEs), on the other hand, are failures associated with healthcare that result in patient harm or even death, most of which are preventable[1]. These events affect the patient's health status, resulting in longer hospital stays, increased morbidity and mortality, and higher healthcare costs[2].

The responsibility for PS lies with all parties involved in healthcare[3], and patient- and family-centered care is an important strategy for preventing AEs and thereby improving PS[4]. Furthermore, this care involves a partnership between healthcare professionals, patients, and their caregivers in healthcare interventions, including participation in care practices and decision-making[4]. For this partnership to occur and for this strategy to be successful, healthcare professionals must provide educational interventions for patients and their caregivers[5]. However, patient education is often neglected by healthcare professionals[6]. Therefore, it is important to educate healthcare professionals about the importance of and ways to educate patients and their caregivers[3].

Health education effectively involves patients, families, and professionals in the care process[3]. In addition, communication and health education have gained prominence as caregivers increasingly seek information about health care and the patient's clinical situation[7]. Improved health communication fosters respectful and trusting relationships between professionals and patients/caregivers, patient engagement in care[7], reduced stress and length of hospital stay, and prevention of adverse events (AEs)[8].

Educational interventions can be conducted digitally, promoting flexible and accessible knowledge[9]. The field associated with using and developing digital technologies is known as digital health[10]. This field aims to improve the healthcare context, increase access to information, and influence improvements in professional routines and the safety of patient care[10].

Digital health includes using information and communication technologies[10], such as mobile applications and web applications. Mobile applications are software available on mobile devices such as smartphones and tablets, while web applications are designed to run within Internet browsers, eliminating the need for software installation[12].

In the healthcare context, both mobile applications and web applications can support decision-making, clinical tracking, and education, benefiting patients, their caregivers, and healthcare professionals at any time and from any location[11].

Thus, mobile applications can contribute to educational support for PS, benefiting healthcare professionals, patients, and their caregivers. Considering the potential of mobile applications for PS and the existing knowledge gap regarding the available applications in virtual stores, it is important to understand the existence of this technology. This can lead to improving and refining its use while highlighting gaps or limitations in the field.

Therefore, this study aims to investigate mobile applications developed to guide professionals, patients, and their caregivers regarding patient safety actions in the context of hospitalization.

METHOD

It is a technological prospection to explore emerging technologies and identify discoveries and developments related to a specific topic[13]. Therefore, this research was conducted by the following steps: 1) defining the research questions and objectives of the search; 2) establishing inclusion and exclusion criteria; 3) defining search strategies; 4) searching virtual stores and the Google search tool; 5) selecting applications; categorizing the results; 6) analyzing the data; 7) presenting the results; 8) concluding and reflecting on the implications of the data analysis[14]. In addition, the standards proposed by the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) were followed[15].

As a first step, the following research questions were formulated based on the study objective What are the applications developed to guide patient caregivers in patient safety actions in the context of hospitalization? What are the applications developed to guide healthcare professionals on patient safety actions in the context of hospitalization? Based on this, the following inclusion criteria were established: mobile applications and web applications focused on patient safety in the context of hospitalization, without a time limit; developed to educate patients and their caregivers or healthcare professionals; available on iOS and/or Android systems and/or websites. Exclusion criteria included: applications in languages other than Portuguese, English, and Spanish; those not related to the topic; repeated on the same platform; or with a purpose other than education.

The search for applications was conducted in April 2022 in the virtual stores App Store and Google Play, using two personal smartphones of the researchers, and the Google search tool using two personal computers of the researchers. The following terms were used in the search: Patient Safety; *Seguridad del Paciente*; Health Education; *Educación en Salud*; Patient Education and Safety; *Jogo Online para Segurança do Paciente*; *Aplicativo para Segurança do Paciente*; *Jogos para prevenção de Erros de Saúde*. The applications were selected independently by two researchers, with disagreements analyzed by a third researcher.

For the organization and analysis of the results, the selected applications were categorized into figures using Microsoft Excel format, including information such as technology name, availability location, original language, category, acquisition type (free or paid), features, user ratings, and current version. The data underwent a comparative qualitative analysis to identify the features developed, their potential, and limitations for use in the hospital context. The analysis was based

on primary literature studies related to the study context. Descriptive strategies and figures were used for the final presentation of the results. This prospective study is part of a larger project with the primary goal of developing a mobile application for pediatric patient safety.

The project is based on Resolution 510/2016 and was submitted and approved by the Research Ethics Committee (RES), receiving the number CAAE: 55983222.9.3001.5129. The protocol containing the methodology used in this prospection was evaluated and validated by experts in health technologies and is registered on the Open Science Framework (OSF) platform with the DOI identifier 10.17605/OSF.IO/PJBGN.

RESULTS

The searches identified 14,570 apps in the online stores and the Google search tool. The steps outlined in the research protocol were then carried out as follows: analysis of the app title to verify compliance with the research questions and the inclusion and exclusion criteria; evaluation of the app characteristics. In this process, 20 mobile apps and 05 web apps were selected for further analysis, including full reading of the descriptions and analysis of their eligibility. From this evaluation, 25 different apps were included in the study, as shown in Figure 1.

The applications were described by name, store where they were available, language, store category, acquisition mode, features, user ratings, and current version, as shown in Figures 2, 3, and 4. It is important to highlight that in the present study sample, there are 07 applications available in both virtual stores. Thus, the overall analysis of the applications was performed by quantifying them as a single occurrence for comparative qualitative analysis, resulting in a total of 25 applications. Only in the analysis of the release year of the applications these 07 applications were not considered duplicates, since 02 of them were launched in different years in the Apple Store and Google Play. Therefore, in the analysis of the year of release, the applications were considered separately, resulting in a final total of 32. The analysis of the applications available on the App Store platform considered the year of release of the first version, except for 03 applications that did not provide this information. The applications from the Google search tool did not contain any information about the year of release. As a result, 03 (9.37%) applications released between 2010 and 2013 were observed, 06 (18.75%) between 2014 and 2017, and finally 15 (46.87%) between 2018 and 2021.

Of the 25 applications analyzed, 16 (64%) are aimed at guiding healthcare professionals (Figure
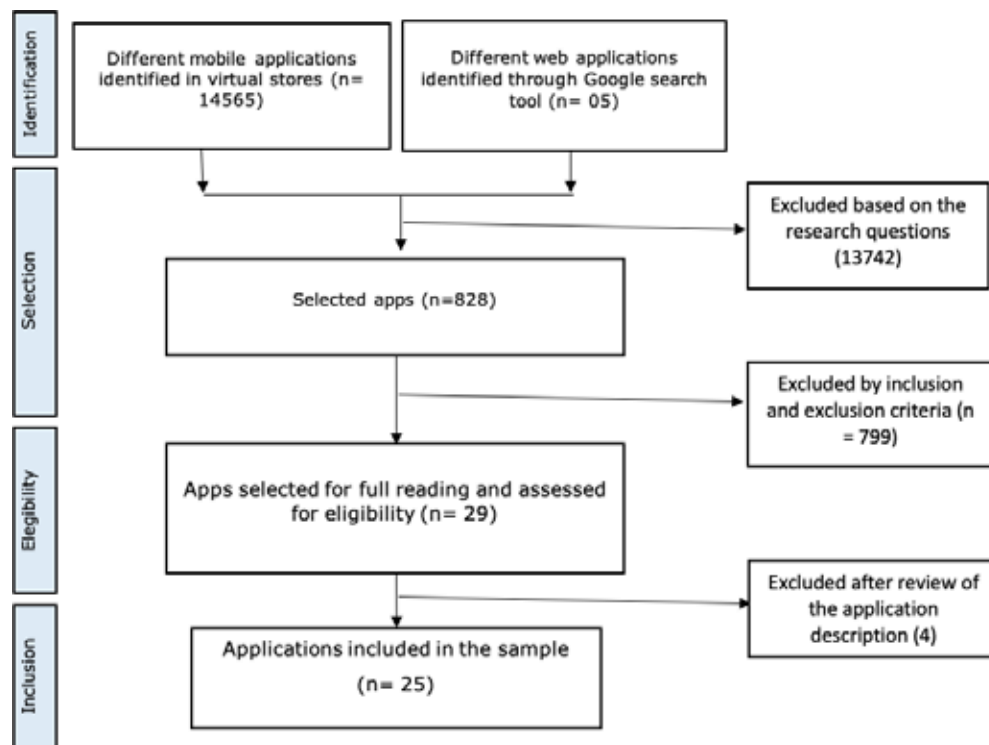
Source: PRISMA-ScR flowchart adapted from Tricco et al., 2018.

Figure 1 – Flowchart of the application selection stages. Belo Horizonte, MG, Brazil, 2022

Name	Store	Language	Category	Acquisition	Features	User ratings	Current version
Guia de *Segurança do Paciente*	Google Play	Portuguese	Books and References	Free	Guide for professionals	None	1.0.2
Health Safety & Patient Care	Google Play	English	Medicine	R$ 9.99	Practical issues for learning and improving skills in patient safety.	None	1.0
Infection Control	Google Play	Inglês	Education	Free	Game to engage students in infection control practices.	None	1.0
NeoMed HSJD	Google Play	Spanish	Medicine	Free	Drug safety information for professionals.	None	1.3
Patient Care & Health Safety	Google Play	English	Education	Free	Practical issues to improve professionals' knowledge and skills in patient safety.	None	1.0
Patient Care Health Safety Flashcards	Google Play	English	Education	Free	Study cards on patient safety.	None	1.2
Patient Safe & Care 1680 Qzs	App Store	English	Medicine	R$ 16.90	Study cards on patient safety.	Not displayed	1.1
Patient Safety AR	Google Play	English	Education	Free	Simulation for professionals to identify risk factors in patient safety.	None	1.1.405
	App Store					Not displayed	1.1.407
Patient Safety Manual	Google Play	English	Medicine	Free	Handbook for professionals on patient safety.	Not displayed	2.3
	App Store						
Pedi Safe Medications	Google Play	English	Medicine	R$ 19.99	Guidance for professionals on drug safety in pediatrics.	4.7	3.4
PICU Essentials	Google Play	Portuguese	Education	Free	Guide for professionals on patient safety.	None	1.4.0.308
	App Store						
Safety + Nurse	Google Play	English	Education	Free	Guidance for professionals on identifying risk factors for patient safety.	None	0.1
	App Store						
Seguridad del Paciente	Google Play	Spanish	Medicine	Free	Guidance on patient safety.	None	1.0.2
MetaVita	Google Search Tool	Portuguese	Education	Free	Game for health professionals.	Not displayed	Not displayed
The Safe Hospital Game	Google Search Tool	Portuguese	Education	Free	Medication safety game for healthcare professionals.	Not displayed	Not displayed
PiccPed	Google Search Tool	Portuguese	Education	Free	Guidelines for in the prevention of pediatric adverse events.	Not displayed	Not displayed

Figure 2 - Characterization of applications included as guidance for health professionals in Technological Foresight. Belo Horizonte, MG, Brazil, 2022

Name	Store	Language	Category	Acquisition	Features	User ratings	Current version
Encision Laparoscopic Surgery	Apple Store	English	Education	Free	Information on patient safety in surgery.	Not displayed	Not displayed
Higiene das mãos SureWah	App Store	Portuguese	Education	Free	Game for correct hand hygiene.	5 out of 5	2.2.1
HSJD Seguro	Google Play	Spanish	Health and Sport	Free	Guidance for patients and families on safety of care.	None	2.0.5
Patients Hospital Safety Guide	Google Play	English	Medicine	R$ 25,99	Guidance on adverse events.	None	1.02
	App Store			R$ 27,90		Not displayed	1.1.0
Safety4me	Google Play	Português	Education	Free	Patient and family guidance on patient safety.	3.6	2.0.20
	Apple Store		Health & Fitness			4.8 out of 5	2.0.21
WHO medsafe	Google Play	English	Medicine	Free	Guidance for patients and families on safe medication.	None	1.6.3
	App Store		Utilities			Not displayed	

Figure 3 - Characterization of the applications included as guidance to patients and their companions in the Technological Prospecting. Belo Horizonte, MG, Brazil, 2022

Name	Store	Language	Category	Acquisition	Features	User ratings	Current version
Projeto Paciente Seguro	Google Search Tool	Portuguese	Education	Free	Games to promote patient safety.	Not displayed	Not displayed
Cuidando Bem	Google Search Tool	Portuguese	Education	Free	Simulation with Patient Safety Protocols.	Not displayed	Not displayed
NSP IPPMG	Google Play	Portuguese	Medicine	Free	Guidance and reporting of adverse events	None	3.0

Figure 4 - Characterization of the applications included as guidance for patients and their companions and health professionals in the Technological Prospecting. Belo Horizonte, MG, Brazil, 2022

2), while 06 (24%) are aimed at patient caregivers (Figure 3) and 03 (12%) have content for both (Figure 4). Considering only the 20 applications found in the virtual stores, 10 (50%) were present only on the Google Play platform, 03 (15%) were found only on the Apple Store, and 07 (35%) were available on both platforms. It was observed that the majority of applications are based on English as their primary language, with 12 (48%) applications in this category, while 10 (40%) are presented in Portuguese and 03 (12%) in Spanish. In addition, it was found that 05 (20%) applications did not have rating and size fields, and 06 (24%) applications did not include information about the current version.

Among the selected applications, 02 (08%) were specifically designed for specific areas of care, one for professionals working in pediatrics and the other for neonatology.

Regarding the acquisition model, 20 (80%) applications were provided free of charge, while 05 (20%) were available for purchase.

Regarding the format of the applications, it was observed that 10 (40%) were games, of which 07 (28%) were aimed at health professionals, 01 (4%) at patients and their caregivers, and 02 (8%) were aimed at both audiences, health professionals and patients with their caregivers. During the observation of the applications, 03 similar applications were identified, namely "Health

Safety & Patient Care", "Patient Care & Health Safety", and "Patient Care Health Safety Flash Cards". Finally, when analyzing all the selected applications, it was found that most of them had design limitations and lacked audiovisual resources and playful features.

DISCUSSION

The conducted technological prospection has allowed the identification of applications developed with the purpose of providing support for healthcare professionals, patients, and their caregivers to play an active role in patient safety actions and the prevention of Adverse Events (AEs). It is noteworthy that patient caregivers, when properly oriented and empowered, play a crucial role in preventing health risks for patients[16]. Supporting this notion, research highlights the lack of dissemination and guidance on safe care for patients and their families, recommending the adoption of mobile applications as tools to promote greater integration between healthcare professionals and patients, emphasizing the importance of co-participatory health care[17]. However, it is relevant to emphasize that few healthcare institutions invest in developing educational actions for patient caregivers[16]. Thus, the results of this study reveal that the majority of applications were developed for healthcare professionals, indicating the need to create applications as educational tools intended for patient caregivers.

Mobile applications provide access to a wide range of information that can be useful during healthcare professionals' clinical practice, serving as a reference tool[18] or educational facilitators[19]. The scientific literature highlights the benefits of this technology, such as increased safety in medication administration, improved care management, AE reporting, enhanced communication, and error prevention barrier systems[20]. However, despite being available, having supporting evidence, and being recommended in the literature, this tool is not yet widely adopted in practice by healthcare professionals[20]. This disconnect between what is prescribed and what is implemented reveals the need for professionals to embrace health technologies more fully[20], from the development phase to the use of these tools in support of safe care.

How healthcare professionals deal with technologies can impact the achievement of the objectives of these tools, such as the quality of healthcare[21]. On some occasions, it is possible to observe that professionals focus more on using equipment related to diagnosis and treatment while underestimating the importance of listening and dialogue[21]. Therefore, it is suggested that applications be used as a support for healthcare professionals in the development of educational activities. This reinforces the importance of combining the use of applications with personal interactions, which are considered lightweight technologies[21] and play a crucial role in the success of health care promotion practices.

When used in complementary ways by patients and their caregivers, applications have shown positive results in reducing health risks and improving care quality[22]. Furthermore, they facilitate information exchange, increased knowledge, and engagement of patients and their caregivers in healthcare[23]. However, for this to happen, it is essential that the information provided by these tools be evidence-based[24].

Validation is closely related to the quality and accuracy of the data and its closeness to reality[25], as it is based on scientific evidence. Therefore, an important highlight of the results of this study was the lack of information on the content and clinical validation of the applications, which may compromise the quality and usefulness of these tools[25]. The lack of information on the validation process of the applications analyzed limits the features that determine their quality, which affects the accuracy of the information and the usability of the tool.

The study also shows an increase in the number of applications available in the last 4 years compared to the last 12 years, indicating a growing availability and adoption of digital tools. In addition, English is the predominant language in the selected applications, which is consistent with findings from other studies[22,26]. These data suggest the need to develop applications in Portuguese, as the use of mobile applications has increased in Brazil in recent years, similar to the international scenario[11].

The updating of applications available on different platforms is a current concern[27], as it optimizes the usefulness of the tool. Mobile application stores generally provide tools that allow for quick updates[27]. However, as pointed out in this study, some applications do not provide information about their updates[28], which can affect the user experience and raise questions about the reliability of the data.

Regarding the availability of applications to the public, the main virtual stores are Google Play

and the Apple Store[29], a result similar to that found in this study. However, it should be noted that making applications available in these stores requires specific programming for each platform, and this process is more complex than making web applications available, which work on different platforms and devices, are easier to manage, and do not require space to download[12]. The scientific literature also points to efforts to develop web applications[12].

In this study, it was possible to identify applications with different names but similar characteristics. In addition, the presence of applications with limited interactivity, limited design, and limited functionalities was noted. This finding is in line with another study that also identified limitations in the availability of information[28], suggesting that these applications may be in the early stages of development[28], which affects the user experience. An application must provide an appropriate level of detail and animation to stimulate and familiarize users. In addition, a well-designed application contributes to advances in scientific knowledge, social innovation, economics, and public policy, which in turn improve the quality of life of the population[30].

Game-based applications represented the largest proportion of the types analyzed and are characterized as interactive and motivational resources for users[31]. In the healthcare context, this approach has shown positive results[31], including increased knowledge, greater adherence to suggested actions[32], and stress reduction[33]. In addition, games have shown superior results compared to traditional teaching methods[34].

In the digital environment, the user experience is crucial, as it is essential to consider the needs and realities of the users[35]. Therefore, it is important to establish a design and functionalities that appeal to the users' senses[35], as familiarity

and comfort are crucial factors to consider[23]. Analyzing the results of this study, a minority of applications have been developed for specific care scenarios, highlighting the need for applications aimed at specific audiences, given the different characteristics of each group.

It is important to note that the present study has limitations related to the scarcity of information available on the app distribution platforms, as this information may be incomplete.

CONCLUSION

There was a lack of applications developed to address PS, particularly with a focus on patients and their families. Within the selected applications, it was found that the majority were available on virtual storefronts and targeted at healthcare professionals, with content predominantly in English and covering different healthcare areas. This analysis highlights the need to develop accessible and interactive patient safety applications for patients and their caregivers, considering the specificities of each care setting.

Therefore, the present study can provide valuable insights for strategic decisions related to healthcare and the development of new applications. This will make a significant contribution to patient safety education, promoting engagement in preventive measures and improving the quality of care for patients and their families.

CONFLICT OF INTERESTS

The authors have declared that there is no conflict of interests.

FUNDING

REFERENCES

1. World Health Organization. Conceptual Framework for the International Classification for Patient Safety [Internet]. Geneva: WHO; 2009 [cited 2022 mai 01]. Available from: https://apps.who.int/iris/bitstream/handle/10665/70882/WHO_IER_PSP_2010.2_eng.pdf

2. Zanetti ACB, Gabriel CS, Dias BM, Bernardes A, Moura AA, Gabriel AB, et al. Assessment of the incidence and preventability of adverse events in hospitals: an integrative review. Rev Gaucha Enferm. 2020;41:e20190364. https://doi.org/10.1590/1983-1447.2020.20190364

3. Biasibetti C, Rodrigues FA, Hoffmann LM, Vieira LB, Gerhardt LM, Wegner W. Patient safety in pediatrics: perceptions of the multi-professional team. Revista Mineira de

Enfermagem. 2020;24:e1337. http://dx.doi.org/10.5935/1415.2762.20200074

4. Cruz AC, Pedreira MLG. Patient-and Family-Centered Care and Patient Safety: reflections upon emerging proximity. Rev Bras Enferm. 2020;73(6):e20190672. https://doi.org/10.1590/0034-7167-2019-0672

5. Franco LF, Bonelli MA, Wernet M, Barbieri MC, Dupas G. Patient safety: perception of family members of hospitalized children. Rev Bras Enferm. 2020;73(5):e20190525. http://dx.doi.org/10.1590/0034-7167-2019-0525

6. Sahlström M, Partanen P, Azimirad M, Selander T, Turunen H. Patient participation in patient safety—An exploration of promoting factors. J Nurs Manag. 2019;27(1):84-92. https://doi.org/10.1111/jonm.12651

7. Souza ADZ, Hoffmeister LV, Moura GMSS. Facilitators and barriers of patient involvement in hospital services: integrative review. Texto Contexto Enferm. 2022;31. https://doi.org/10.1590/1980-265X-TCE-2020-0395en

8. Davidson JE, Aslakson RA, Long AC, Puntillo KA, Kross EK, Hart J, et al. Guidelines for Family-Centered Care in the Neonatal, Pediatric, and Adult ICU. Crit Care Med. 2017;45(1):103-128. https://doi.org/10.1097/CCM.0000000000002169

9. Nascimento KG, Ferreira MBG, Felix MMS, Nascimento JSG, Chavaglia SRR, Barbosa MH. Efetividade do serious game para a aprendizagem na enfermagem: revisão sistemática. Rev Gaucha Enferm. 2021;42:e20200274. https://doi.org/10.1590/1983-1447.2021.20200274

10. World Health Organization. Global strategy on digital health 2020-2025 [Internet]. Geneva: WHO; 2021 [cited 2022 mai 01]. Available from: https://www.who.int/docs/default-source/documents/gs4dhdaa2a9f352b-0445bafbc79ca799dce4d.pdf

11. Pires IM, Marques G, Garcia NM, Flórez-Revuelta F, Ponciano V, Oniani S. A research on the classification and applicability of the mobile health applications [Internet]. Journal of Personalized Medicine. 2020 [cited 2022 mai 01];10(1). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7151562/

12. Fortunato D, Bernardino J. Progressive web apps: An alternative to the native mobile Apps. In: Iberian Conference on Information Systems and Technologies, CISTI [Internet]. Caceres (ES): IEEE Computer Society; 2018 [cited 2022 mai 01]. p. 1–6. Available from: https://ieeexplore.ieee.org/document/8399228

13. Tourinho FSV, Schuelter PI, Fermo VC, Caldas MM, Alves TF, Barbosa SS. Desenvolvimento de Tecnologias em Pesquisa e Saúde: da Teoria à Prática [Internet]. Guarujá (SP): Científica Digital; 2022 [cited 2022 nov 01]. Available from: https://www.editoracientifica.com.br/livros/livro-desenvolvimento--de-tecnologias-em-pesquisa-e-saude-da--teoria-a-pratica

14. Aromataris E, Munn Z, editors. JBI Manual for Evidence Synthesis [Internet]. Adelaide: JBI; 2020 [cited 2022 mai 01]. Available from: https://jbi-global-wiki.refined.site/space/MANUAL. https://doi.org/10.46658/JBIMES-20-01

15. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. Annals of Internal Medicine. 2018:467-473. https://doi.org/10.7326/M18-0850

16. Gonçalves KMM, Costa MTTCA, Silva DCB, Baggio ME, Corrêa ADR, Manzo BF. Ludic strategy for promoting engagement of parents and caregivers in the safety of pediatric patients. Rev Gaucha Enferm. 2020;41(1):e20190473. https://doi.org/10.1590/1983-1447.2020.20190473

17. Siqueira C, Dias AP. Estratégias para o envolvimento da família em um cuidado seguro: um estudo de revisão. Oikos: Família e Sociedade em Debate. 2021;32(1):299-317. https://doi.org/10.31423/oikos.v32i1.10287

18. Souza S, Rocha PK, Avelar AFM, Tomazoni A, Anders JC, Ullman A. Piccped® mobile application: Prevention of adverse events in a peripherally inserted central catheter in pediatrics. Texto Contexto Enferm. 2021;30:e20200627. https://doi.org/10.1590/1980-265X-TCE-2020-0627

19. Caldas MM, Tourinho FSV, Radünz V, Fermo VC, Ilha P, Alves TF. Mobile application for error prevention in medication: Prevmed. Ciencia y Enfermeria. 2020;26(4):1–9. http://dx.doi.org/10.4067/s0717-95532020000100401

20. Ferreira AMD, Oliveira JLC, Camillo NRS, Reis GAX, Évora YDM, Matsuda LM. Perceptions of nursing professionals about the use of patient safety computerization. Rev Gaúcha Enferm. 2019;40(esp):e20180140. https://doi.org/10.1590/1983-1447.2019.20180140

21. Lisboa NA, Santos SF, Lima EI. A importância das tecnologias leves no processo de cuidar na atenção primária em saúde. Revista Textura [Internet]. 2017 [cited 2022 dez 01];10(19):164-171. Available from: https://textura.emnuvens.com.br/textura/article/view/53

22. Oliveira LB, Vilhena BJ, Freitas RN de, Bastos ZRG, Teixeira E, Menezes EG, Diniz CX, et al. Aplicativos Móveis No Cuidado Em Saúde: Uma Revisão Integrativa. Rev Enferm Atual In Derme. 2020;93(31):e-020047. https://doi.org/10.31011/reaid-2020-v.93-n.31-art.760

23. Russ S, Sevdalis N, Ocloo J. A smartphone app designed to empower patients to contribute toward safer surgical care: Qualitative evaluation of diverse public and patient perceptions using focus groups. JMIR Mhealth Uhealth. 2021;9(4):e24065. https://doi.org/10.2196/24065

24. Cestari VRF, Florêncio RS, Garces TS, Souza LC, Pessoa VLMP, Moreira TMM. Mobile app mapping for heart failure care: a scoping review. Texto Contexto Enferm. 2022;31:e20210211. https://doi.org/10.1590/1980-265X-TCE-2021-0211

25. Polit DF, Tetano Beck. Fundamentos de Pesquisa em Enfermagem: Avaliação de Evidências para a Prática de Enfermagem. 7 ed. Artmed. 2011.

26. Barra DCC, Paim SMS, Sasso GTM, Colla GW. Methods for developing mobile apps in health: an integrative review of the literature. Texto Contexto Enferm. 2017;26(4):e2260017. https://doi.org/10.1590/0104-07072017002260017

27. McIlroy S, Ali N, Hassan AE. Fresh apps: an empirical study of frequently-updated mobile apps in the Google play store. Empir Softw Eng. 2016;21:1346–1370. https://doi.org/10.1007/s10664-015-9388-2

28. Schnall R, Iribarren SJ. Review and analysis of existing mobile phone applications for health care-associated infection prevention. Am J Infect Control. 2015;43(6):572–576. https://doi.org/10.1016/j.ajic.2015.01.021

29. Andrade APV, Ramos ASM. Engajamento dos Consumidores com o Boca a Boca Eletrônico Negativo em Lojas de Aplicativos Móveis. Revista de Administração Contemporânea. 2017;21(6):788–810. https://doi.org/10.1590/1982-7849rac2017160318

30. Souza DLD, Souza TAD, Zambalde AL. Pesquisa acadêmica e avanços em Ciencia, Tecnologia e Inovação (CT&I): uma proposta de aproximação pela Design Science. Cad EBAPERB. 2020;18(3):459-472. https://doi.org/10.1590/1679-395120190039

31. Heidel A, Hagist C. Potential benefits and risks resulting from the introduction of health apps and wearables into the German statutory health care system: Scoping review. JMIR. 2020;8(9):e16444. https://doi.org/10.2196/16444

32. Kim HJ, Kim SM, Shin H, Jang JS, Kim YI, Han DH. A Mobile Game for Patients With Breast Cancer for Chemotherapy Self-Management and Quality-of-Life Improvement: Randomized Controlled Trial. *JMIR*. 2018;20(10):e273. https://doi.org/10.2196/jmir.9559

33. Yogman M, Garner A, Hutchinson J, Hirsh-Pasek K, Golinkoff RM, Baum R, et al. The power of play: A pediatric role in enhancing development in young children. Pediatrics. 2018;142(3):e20182058. https://doi.org/10.1542/peds.2018-2058

34. Nascimento KG, Ferreira MBG, Felix MMDS, Nascimento JSG, Chavaglia SRR, Barbosa MH. Effectiveness of the serious game for learning in nursing: systematic review. Rev Gaucha Enferm. 2021;42: e20200274. https://doi.org/10.1590/1983-1447.2021.20200274

35. Garrett JJ. The elements of user experience: user-centered design for the Web and beyond. 2. ed. New Riders. 2010.

AUTHORSHIP CONTRIBUTIONS

Project design: Mendes LA, Antunes CC, Alves TF, Manzo BF
Data collection: Mendes LA, Antunes CC, Manzo BF
Data analysis and interpretation: Mendes LA, Antunes CC, Alves TF, Manzo BF
Writing and/or critical review of the intellectual content: Mendes LA, Antunes CC, Alves TF, Manzo BF
Final approval of the version to be published: Mendes LA, Antunes CC, Alves TF, Manzo BF
Responsibility for the text in ensuring the accuracy and completeness of any part of the paper: Mendes LA, Antunes CC, Alves TF, Manzo BF