J Bras Pneumol. 2023;49(5):e20230201
https://dx.doi.org/10.36416/1806-3756/e20230201

Mobile health applications designed for self-management of chronic pulmonary diseases in children and adolescents: a systematic mapping review

Vaia Sapouna[1,2], Pavlos Kitixis[1], Elpiniki Petrou[1], Theano Michailidou[1], Panagiotis Dalamarinis[1], Eleni Kortianou[1]

1. Clinical Exercise Physiology and Rehabilitation Laboratory, Physiotherapy Department, Faculty of Health Sciences, University of Thessaly, Lamia, Greece.
2. Physical Medicine and Rehabilitation Centre Kentavros, Volos, Greece.

Submitted: 11 June 2023.
Accepted: 24 July 2023.

Study carried out in the Clinical Exercise Physiology and Rehabilitation Laboratory, Physiotherapy Department, Faculty of Health Sciences, University of Thessaly, Lamia, Greece.

ABSTRACT

Objective: Mobile health (mHealth) applications are scarce for children and adolescents with chronic pulmonary diseases (CPDs). This study aimed to map and describe the contents of the mHealth apps available for use in children and adolescents with CPDs. **Methods:** We performed a systematic mapping review of published scientific literature in PubMed, Scopus, and Cochrane Library by February of 2023, using relevant keywords. Inclusion criteria were as follows: children aged < 18 years with CPDs; and studies published in English on mHealth apps. **Results:** A total number of 353 studies were found, 9 of which met the inclusion criteria. These studies described seven mHealth apps for Android and iOS, designed either for asthma (n = 5) or for cystic fibrosis (n = 2). Five content areas were identified: education/information; pharmacological treatment; emergency; support; and non-pharmacological treatment. The studies (4, 2, and 3, respectively) showed consistent findings using qualitative, quantitative, and mixed methodologies. **Conclusions:** This mapping review provided a guided selection of the most appropriate mHealth apps for use in children and adolescents with CPDs based on the needs of each target population. However, these mHealth apps have limited capabilities to reinforce disease self-management and provide information related to treatment compliance.

Keywords: Lung diseases; Child, Adolescent; Treatment adherence and compliance; Telemedicine; Self-management.

INTRODUCTION

In pediatrics, effective disease management includes taking medications as prescribed, attending medical appointments, self-monitoring symptoms, identifying and minimizing exposures to environmental triggers, adhering to a personalized action plan, and communicating with health-care providers about symptoms and treatments.[1] Traditionally, clinic visits serve as the primary setting for pediatric patients to receive disease education and self-management support. However, children and caregivers are increasingly looking for self-manageable information and assistance and are directed to alternate ways of support such as using relevant websites and mobile health (mHealth) applications (apps).[2]

Mobile phone usage is rapidly increasing around the world.[3] In 2019, almost 46% of children between 5 and 17 years of age in Europe had a smartphone, and 41% of these used it daily.[4] This new reality has been conducive to the adoption of this technology to support medical and public health practice services.[5] Therefore, mHealth apps have become a promising tool to provide support to kids and caregivers so that they could manage therapy regimens and symptoms, aiming to enhance the self-management of chronic diseases and, consequently, improve the quality of life of these patients. Apps created for managing chronic pulmonary diseases (CPDs) usually include functions such as written reminders, information about medication intake, symptom records, and pulmonary function monitoring, as well as education about disease pathology.[2,6-9]

Further to this attempt, the exchanged information between patients and clinicians (such as patients' pre-visit reports as an Adobe Acrobat PDF file prior to the clinical visit) can be broadened by mHealth technology. In other words, this technology can facilitate the estimation of the symptoms and the modification of pharmacological and non-pharmacological treatment regimens when necessary, as well as the process of detecting a disease exacerbation.[2,8] Although mHealth apps are optimally designed to provide support in disease self-management and to empower individuals to comply with treatment, very few apps have been investigated regarding their impact on clinical outcomes.

This review article aims to map and classify the existing studies about mHealth apps designed to be used for the pharmacological and non-pharmacological management of CPDs in children and adolescents. Acknowledging some boundaries in the classification of the existing

Correspondence to:
Eleni Kortianou. 3rd Old National Road Lamia-Athens, 35100, Lamia, Greece.
Tel.: 302 231060246. Fax: 302 231033945. E-mail: ekortianou@uth.gr
Financial support: None.

apps, clinicians can make evidence-based decisions regarding which app is the most suitable for use or can suggest new fields of interest when realizing any research gaps.

METHODS

Study design

A systematic mapping review methodology was used in order to find published studies regarding mHealth apps designed for self-management of CPDs in children and adolescents.[10] Our approach was based on the principles defined by the Social Care Institute for Excellence.[11] A systematic map is increasingly being used in health care service research aiming to map out and categorize a topic in the literature to undertake new and more detailed work.[10] This method is useful for summarizing and organizing a broad, heterogeneous evidence base to identify more specific investigations.[11] A protocol was registered on the Open Science Framework platform (https://doi.org/10.17605/OSF.IO/ADKGF) since the International Prospective Register of Systematic Reviews is not currently accepting registrations for mapping reviews.

Eligibility criteria

Inclusion criteria were articles published in the English language by February of 2023. Studies on children with CPDs (such as asthma, cystic fibrosis, and non-cystic fibrosis bronchiectasis) who were younger than 18 years of age, and who used mHealth apps that had a user-friendly behavioral approach were included in this review. Abstracts, book reviews, book chapters, narrative reviews, preclinical studies, scoping reviews, systematic reviews, meta-analyses, case series/reports, commentaries, letters to the editor, editorials, clinical practice guidelines, protocols, and studies whose full texts were unavailable were excluded. Furthermore, studies were excluded if they were related to adults or to other chronic or acute pediatric diseases (such as musculoskeletal and neurological diseases), or if the research process for mHealth app design and interventions were not described. In this mapping review, unpublished reports and gray literature were chosen not to be searched.

Search strategy

A systematic electronic literature search was performed across three electronic databases (PubMed, Scopus, and Cochrane Library) by February of 2023 by one of the researchers (VS). Search strategy was designed using keywords and MeSH terms related to mHealth apps, pharmacological/non-pharmacological treatment, children/adolescents, and CPDs (Supplementary material).

Screening and article selection

Studies were screened for inclusion by reviewing the title and abstract. Search results were exported to Endnote X9 (Clarivate, Philadelphia, PA, USA). After exclusion of duplicates, two investigators (VS and PK) independently screened the titles, abstracts, and full texts of the studies to make a final decision. Studies that did not meet the eligibility criteria were excluded. Afterward, a secondary search was performed from citations in the included articles and in previous reviews about the use of mHealth apps. The full texts of all relevant studies were sought, downloaded, and further evaluated for compliance with the eligibility criteria. In case of disagreements, a third reviewer (EK) was consulted to make the final decision, thus ensuring the minimization of bias when deciding whether to include a study or not. Finally, all of the members of the research team decided on the inclusion of the selected studies by consensus.

Data extraction

Given the relatively few relevant studies in the literature, we decided to include studies using different methodologies. A template including the study methodology, study setting, year of publication, and main perspectives was developed to guide data extraction. VS and EP independently extracted the data from the included articles, and EK undertook final verification. Any disagreement was discussed and resolved by consensus.

Based on Fernández-Sotos et al.,[12] a key methodological aspect for a successful systematic mapping review is the definition of research questions (RQs) to be answered. Therefore, the selected RQs in this mapping review were as follows:

- RQ1: What are the mHealth apps available for use in children and adolescents with CPDs?
- RQ2: What is the content of each mHealth app?

Risk of bias/quality of the studies

The main aim of a systematic mapping review is to describe the state of the art of the topic.[11] Risk of bias is determined in a generic way by classifying the study type. This systematic mapping review was conducted to provide an overview of the existing mHealth apps regardless of methodological quality or risk of bias derived from each study. Therefore, sources of evidence are not critically appraised, and they were reviewed in terms of research coherence and utility of findings on the main research focus.[12]

RESULTS

Flow of studies

The electronic search strategy identified 353 relevant papers. After removing duplicates, 164 studies were reviewed by title and abstract. A total of 129 studies were excluded. Of the 35 full-text studies assessed for eligibility, 9 were included for further study. Figure 1 shows the flow chart of the study selection process in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses recommendations.

Characteristics of the studies selected

Table 1 provides a summary of the characteristics of the studies included. Four studies were conducted based on qualitative methods,[2,8,13,14] two were quantitative descriptive studies,[15,16] and three studies adopted mixed research methods.[7,17,18] Four, two, and three studies, respectively, were conducted in Europe,[2,7,8,16] in the USA,[14,15] and in Australia[13,17,18] between 2017 and 2022. Four of the studies used a sample of pediatric patients with CPDs,[2,13,15,16] two other studies used a sample consisting of all of the stakeholders (patients, health care professionals [HCPs], and parents),[8,14] and one study used a sample of the Australian First Nations Health and Care with HCPs and carers of children with asthma.[18] In addition, one study used a sample consisting of mHealth apps,[7] and another study used a sample consisting of students.[17]

RQ1: What are the mHealth apps available for use in children and adolescents with CPDs?

Among the studies included in the present systematic mapping review, seven specific mHealth apps[7] were mentioned (Table 2). In detail, two of the reviewed studies assessed an app named Genia, which is addressed to patients with cystic fibrosis (CF).[2,14] Two studies examined the mHealth application named MyCyFAPP, which was developed as a self-management tool for patients with CF and their families.[8,16] In addition, five apps (for iOS and Android) were addressed to patients with asthma: Kiss my Asthma;, Ask Me, AsthMe!; ASTHMAXcel; Asthma First Aid; and Menzies Asthma APP.[7,13,15,17,18]

The Genia app was designed for iOS and aims to foster collaboration among CF patients (mean age = 17.8 years), their families, and health care teams, with

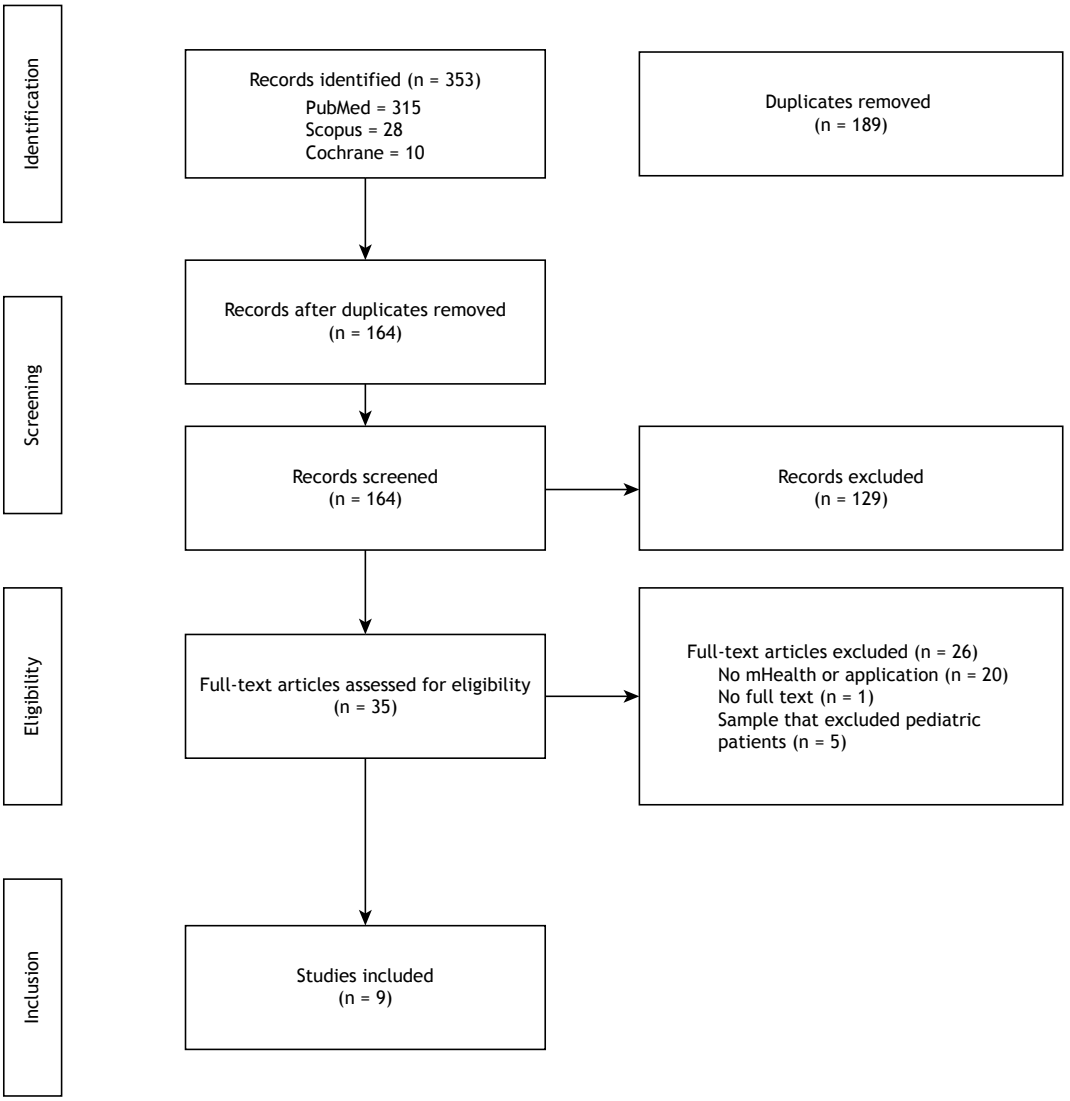

Figure 1. Flow chart of the selection process in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations.

a particular focus on giving children and adolescents a central role in the decision-making process. The app was created by Upstream Dream, a Swedish-based company, and it was funded as a collaborative project with Genentech. As a platform and an app-based patient support system, the Genia app emphasizes user participation, feedback provision, and collaborative content shaping. The core functionality of the system was commissioned as part of a collaborative learning initiative related to a special clinical microsystem, named Lund Pediatric Cystic Fibrosis. This involved clinicians, researchers, family members, and CF patients in order to determine the contents of the app, and core functions were optimized and inspired by patients.[2,14]

The MyCyFAPP app was designed for Android to be used by children and adolescents with CF (< 18 years of age), their families, and HCPs, who can jointly and seamlessly manage the treatment of the disease. A multidisciplinary project (designated Horizon 2020 and spanning four years—from January 1st, 2015 to December 31st, 2018) was created and funded by the European Commission Framework Program for Research and Innovation. Patients and families can rely on the app to self-manage nutrition and other aspects of non-pharmacological and pharmacological treatment. HCPs use this tool to monitor and track patient progress, ensuring feedback between the two parties when deemed necessary.[8,16]

The Kiss my Asthma app was developed by a research team from the University of Sydney, the Woolcock Institute of Medical Research, and the University of Melbourne, with funding from the Asthma Australia's National Research Fund. The app is available on both iOS and Android platforms, and it provides users (< 18 years of age) with convenient access to their asthma action plan, medication reminders, tips on avoiding triggers, and strategies for managing asthma. Additionally, the app offers educational resources about asthma and allows users to set personal goals. By making small changes, users can reduce the frequency of asthma flare-ups and improve their overall asthma control. The ultimate aim of the app is to help users lead normal lives and not let asthma symptoms affect their daily activities.[13]

The Ask Me, AsthMe! app was designed for iOS to help children (12-18 years of age) and their families increase their knowledge about pediatric asthma and manage asthma symptoms effectively. The app was created by the New York City Health and Hospitals Corporation without any funding. It is an app with a number of functions aiming to help users understand childhood asthma and asthma parameters. In fact, the app has been positively evaluated and considered to be able to contribute to the management of childhood asthma.[7]

Table 2. mHealth apps and target patient population.

App	Target population
Genia[2,14]	Cystic fibrosis
MyCyFAPP[8,16]	Cystic fibrosis
Kiss my Asthma[13]	Asthma
Ask Me, AsthMe![7]	Asthma
ASTHMAXcel[15]	Asthma
Asthma First Aid[17]	Asthma
Menzies Asthma[18]	Asthma

Table 1. Summary characteristics of the studies included in the mapping review.

Characteristic	Number of studies (reference)
Methodology	
Qualitative	4[2,8,13,14]
Quantitative	2[15,16]
Mixed methods	3[7,17,18]
Study setting	
Europe	4[2,7,8,16]
USA	2[14,15]
Australia	3[13,17,18]
Year of publication	
2017	3[8,13,16]
2018	1[2]
2019	-
2020	1[15]
2021	3[7,14,17]
2022	1[18]
Main perspective	
Pediatric patients (CF/Asthma)	4[2,13,15,16]
Stakeholders (CF patients, parents, and HCPs)	2[8,14]
AFNHC's HCPs Health professionals and carers of children with asthma	1[18]
Sample of apps	1[7]
Sample of students	1[17]

CF: cystic fibrosis; HCPs: health care professionals; and AFNHC: Australian First Nations Health and Care.

ASTHMAXcel is an evidence-based, personalized app for managing asthma symptoms, developed by a team of asthma physicians, software programmers, and behavioral scientists. The work was funded by the Allergic Respiratory Diseases Research Award sponsored by the American Lung Association and the American Academy of Allergy, Asthma and Immunology Foundation. The project was supported by the Stony Wold-Herbert Fund Community Service Grant and the Genentech Research Grant. As part of the ASTHMAXcel program, a gamified mobile app called ASTHMAXcel Adventures was developed for children and adolescents with asthma (7-17 years of age), available on iOS and Android platforms. The app features short educational videos and interactive games that combine animation with informative storytelling. It has an introductory screen with five levels for users to choose from. Each level comprises one to three tutorial videos and corresponding games that require users to answer questions related to the videos.[15]

The Asthma First Aid app is a useful tool for an asthma emergency, available on both iOS and Android platforms. It was created by Asthma Australia (National Health and Medical Research Council Centre for Research Excellence in Lung Health) as an educational tool for children with asthma (12-18 years of age), their families, and their carers, providing easy access to emergency response steps. It covers both first aid in event of an asthma emergency plus the ability to review each of the four first aid steps.[17]

The Menzies Asthma app is a First Nations-specific, multi-lingual app that is based on the current pediatric pictorial asthma flipchart, with "voice-over" in seven First Nations languages and English. This project was funded by Asthma Australia and it was produced by the Child Health Division of Menzies School of Health Research. It uses interactive images, audio, and quizzes to teach children (4-18 years of age) about asthma. It is an innovative and culturally acceptable method of delivering evidence-based respiratory health education to culturally and linguistically diverse populations among First Nations people in Australia.[18]

RQ2: What is the content of each mHealth app?

Table 3 shows the main aspects searched in relation to the content of each app. Five main content areas were identified: education/information, pharmacological treatment, emergency, support, and non-pharmacological treatment.

Six of the included apps offer information about the disease through educational videos, contributing to self-management of the disease and improving the cognitive background of both children and parents.[7,8,13,15-18] Four apps function as pharmacological diaries.[2,7,8,13,14,16] Furthermore, four apps indicate emergency procedures for pediatric patients with asthma attacks.[7,13,17,18] Information about symptoms and medication reminders is provided in four apps.[2,7,8,13,14,16] Finally, two of the apps can provide non-pharmacological elements focusing on nutritional aspects of children with CF and compliance with performing respiratory physical therapy exercises using an emotion expression scale score.[2,8,14,16]

Education/information

The MyCyFAPP has educational resources and tools for customized nutritional self-management of the disease and patient empowerment. These educational tools are a nutritional recommendation handbook, full of practical examples and applicable recommendations written in plain and easy-to-read language, including images, infographics, and layouts; a mobile game for tablets, named My Happy Pat, which was designed for children with CF between 4 and 11 years of age; a tool specifically designed to create recipes based on complete and reliable nutritional composition databases, named MyFoodCAL; a tool that enhances and reformulates existing nutritional composition databases by adding new foods and filling nutritional information gaps, named MyFoodFACTS; and an online tool to compile case reports, named MyFoodREC.[8,16]

For patients with asthma, there are also educational resources available to help learning about the disease, including symptoms, causes, and effective management techniques. The Ask Me, AsthMe! app provides educational resources to help users (patients and parents) to learn about asthma, its symptoms and causes, and manage their condition more effectively.[7] The ASTHMAXcel app contains educational videos on how asthma affects the airways, medications and how they work, flow meter monitoring, and instructions on how to use inhalers and spacers properly.[15] Additionally, the Kiss my Asthma, the Asthma First Aid, and the Menzies Asthma apps provide educational

Table 3. Main content areas in each mHealth app.

App	Education/ information	Pharmacological treatment	Emergency	Support	Non-pharmacological treatment
Genia[2,14]		☺		☺	☺
MyCyFAPP[8,16]	☺	☺		☺	☺
Kiss my Asthma[13]	☺	☺	☺	☺	
Ask Me, AsthMe![7]	☺	☺	☺	☺	
ASTHMAXcel[15]	☺				
Asthma First Aid[17]	☺		☺		
Menzies Asthma APP[18]	☺		☺		

instructions on how to manage asthma attacks and when to seek medical attention.[13,17,18]

Pharmacological treatment

The Genia app allows patients to track their medication intake and share comments, helping users keep a record of when they took their medicine and note which medicine was, thereby facilitating medication management.[2,14] The MyCyFAPP includes a personalized medication plan for each individual user.[8,16] This plan includes a customized dosage per intake, recurrence, and medication termination, and provides reminders for medical doses. Users can also track their medication adherence over time using this resource.[8,16] For children with asthma, the Kiss my Asthma and the Ask Me, AsthMe! apps contain a field for recording a medication diary.[7,13] This can help children keep track of their medication schedule and ensure that they are adhering to their prescribed treatment plan.

Emergency

The Kiss my Asthma app offers access to an action plan, first aid instructions, and emergency contacts, as well as information about asthma, asthma medication and devices, and provides instructions for anxiety management.[13] The Ask Me, AsthMe! app provides step-by-step instructions on what to do in an emergency situation. The instructions are organized in color-coded zones, making it easy to understand and follow them.[7] The Asthma First Aid app allows users to follow first aid steps in real time in an attack mode and review the first aid steps using a sample of scenarios in a training scenario mode.[17] The Menzies Asthma app helps children learn the four steps to take during an asthma emergency and what to do when symptoms do not improve.[18]

Support

By using the Genia app, patients or parents can record health observations and symptoms between visits daily (e.g., physical activity or gastrointestinal problems), track medication intake, and complete pre-visit reports, including treatment preferences and goals, prior to a clinical appointment. This patient-reported information allows patients to document their disease activity and preferences in real time between clinical visits.[2,14] The MyCyFAPP provides medication reminders that help users remember to take their medications on time, reminders of HCP appointments, and progress tracking. The app also includes a symptom tracker, which allows users to monitor their symptoms over time and share this information with HCPs, offering flexibility to accommodate appointments with daily recurrences, termination dates, or different medicine dosages.[8,16] For patients with asthma, the Kiss my Asthma app provides the option through which the user can receive self-defined notifications about the use of an asthma control device as well as information about the supporting environment and direct contact information. This tool can help children stay on track with their treatment plans and monitor their asthma control.[13]

Non-pharmacological treatment

The Genia app functions as a self-report diary by allowing children with CF to record and save observations about various aspects of their condition.[2,14] It includes features related to lung function, airway clearance, physical activity, appetite, and other supportive therapies. They can share their thoughts, feelings, and any observations that they have regarding their therapy routine. It gives them a chance to express how they perceive the therapy, whether they find it helpful or challenging, and if they have any concerns or suggestions related to it. By collecting this information through the Genia app, HCPs and caregivers can gain valuable insights into the child's perspective and make informed decisions regarding their treatment plan. It also empowers children to participate in their care actively and be involved in the management of their condition.[2,14] The MyCyFAPP offers a personalized nutrition plan, which is tailored to the individual's needs based on their age, weight, height, and other factors. The nutrition plan provides information on recommended calorie intake, meal planning, and portion sizes, and allows users to track their daily food intake.[8,16]

DISCUSSION

This review aimed to map and classify the existing studies about mHealth apps designed to be used for the pharmacological and non-pharmacological self-management of CPDs in children and adolescents.

The implementation of a co-design approach that engages multiple stakeholders holds great promise in facilitating CPD self-management.[2,8] This collaborative process serves two key purposes: firstly, it helps identify and address divergences among stakeholders, thus leading to effective solutions. Secondly, it enables to design concepts that align with functional requirements (e.g. reminders, notifications, educational resources, and support), as well as nonfunctional aspects such as privacy and time saving.[8] Research on the development of mHealth technology promotes the incorporation of the end user in the design process; however, their input is often incorporated late or sporadically during the design phase.[19] Some apps in this domain have successfully embraced co-design to enrich their content and support disease self-management.[2,8] The design of the apps is very important so that users can increase their interaction and gain more benefits from the therapeutic treatment. However, only one app was tested in clinical studies with regard to its effectiveness in supporting disease self-management.[20]

The selected mHealth apps in this mapping review cover a range of essential areas, providing valuable content in five key domains: education/information,

pharmacological treatment, emergency assistance, support, and non-pharmacological treatment. Each of these components offers distinct benefits and outcomes to the users.

The education/information aspect provides valuable knowledge and resources to enhance disease understanding and management.[7,8,13,15-18] Pharmacological treatment modules focus on supporting medication adherence and optimizing treatment outcomes.[2,7,13,14,16] Emergency assistance features ensure prompt access to assistance and resources during critical situations, such as an asthma attack.[7,13,17,18] Non-pharmacological treatment tools provide alternative approaches and strategies for disease self-management.[2,8,14,16] These comprehensive components collectively contribute to a holistic and well-rounded user experience with the selected mHealth apps. Lastly, support functionalities offer a sense of community and emotional support to individuals with the condition.[2,7,13,14,16]

The reassessment of the apps by users (children, adolescents, parents, and HCPs) has been proven to be invaluable for improving the functionality of each app. Users express a strong desire to communicate with their HCPs, share comprehensive information about their symptoms, and receive reminders for medication adherence. Users' requests during app reassessment play a pivotal role in significantly modifying the content within the apps. As a result, features such as symptom monitoring, suggested therapies, prescribed medications, and other activities related to daily therapy have been incorporated to enhance usability and user-friendliness. It is worth noting that, initially, the apps did not fully encompass these functionalities; however, they have undergone substantial improvements with user evaluation and feedback.[2,8,14] Interestingly, it should be noted that there were limitations in the capabilities of some mHealth apps to reinforce disease self-management fully and provide comprehensive information related to compliance with treatment.

Overall, this review highlights the potential of mHealth technology in empowering children and adolescents with CPDs through self-management. The findings underscore the significance of a co-design approach that engages all relevant stakeholders. By leveraging the strengths of mHealth apps across education, pharmacological treatment, emergency assistance, support, and non-pharmacological treatment domains, self-management support and patient-physician communication can be provided to children with CPDs and their families, and this powerful tool can enhance their ability to manage disease symptoms and improve health outcomes and quality of life. Further research with randomized control trials and long-term follow-up of the use of these apps in pediatric populations with CF, asthma, and non-CF bronchiectasis are necessary to address the potential benefits of these apps in supporting pediatric patients to manage their conditions effectively.

This systematic mapping review has some limitations. Even though our research included three different scientific databases, the research strategy was jeopardized by the exclusion of other databases that could have brought more studies into light. Furthermore, our search was limited to studies published only in English, which might have excluded valuable sources of information published in other languages. However, we believe that there is relatively little research evidence addressing the specific questions selected, which is reflected by the small number of studies fitting the quite specific inclusion criteria in this review. Moreover, the heterogeneity of methodologies and contexts in the included studies presents a challenge in drawing together related and contrasting findings. In addition to the aforementioned limitations, it is worth noting that there was a lack of direct communication between our team of researchers and the authors of the studies, which limited the opportunity for further considerations and potential insights. The absence of such collaboration might have resulted in a potential decrease in the depth and breadth of information gathered in this review.

FINAL CONSIDERATIONS

mHealth apps are increasingly becoming an integral part of the new era of eHealth. These tools incorporate various features and functions, aiming to support users and improve compliance with treatment, and, as a consequence, improving disease self-management. Specifically focusing on apps for children/adolescents, mHealth apps are designed with a user-centric approach, taking into consideration feedback from patients, parents/caregivers, and HCPs. This collaborative effort aims to enhance the functionality of the apps, ensuring that they meet the specific needs and preferences of their intended users. This mapping review identified five content areas in mHealth apps for children with CPDs: education/information, pharmacological treatment, emergency, support, and non-pharmacological treatment. The challenge for HCPs lies in selecting a final and improved product. To guarantee usability and effectiveness in achieving clinical outcomes such as promoting adherence to pharmacological and non-pharmacological treatments and improving the quality of life, further clinical studies involving these patients are necessary. These studies will provide valuable insights into the impact and efficacy of the apps, ultimately contributing to their continued development and refinement.

ACKNOWLEDGMENTS

The authors would like to thank Mr. Nicholas Nikolovienis for editing the final manuscript.

AUTHOR CONTRIBUTIONS

VS and EK: study concept and design; drafting of the manuscript; critical review of intellectual content; and

writing of the final version of the manuscript. VS, PK, EP, TM, and PD: data analysis and interpretation. All authors approved the final version of the manuscript.

CONFLICTS OF INTEREST

None declared.

REFERENCES

1. Catarino M, Charepe Z, Festas C. Promotion of Self-Management of Chronic Disease in Children and Teenagers: Scoping Review. Healthcare (Basel). 2021;9(12):1642. https://doi.org/10.3390/healthcare9121642
2. Longacre M, Grande S, Hager A, Montan M, Bergquist RP, Martensson M, et al. Clinical Adoption of mHealth Technology to Support Pediatric Cystic Fibrosis Care in Sweden: Qualitative Case Study. JMIR Pediatr Parent. 2018;1(2):e11080. https://doi.org/10.2196/11080
3. Licari A, Ferrante G, Marseglia Md GL, Corsello Md G, La Grutta S. What Is the Impact of Innovative Electronic Health Interventions in Improving Treatment Adherence in Asthma? The Pediatric Perspective. J Allergy Clin Immunol Pract. 2019;7(8):2574-2579. https://doi.org/10.1016/j.jaip.2019.08.008
4. Mascheroni G, Ólafsson K. The mobile Internet: Access, use, opportunities and divides among European children. New Media Soc. 2016;18(8):1657-1679. https://doi.org/10.1177/1461444814567986
5. Kosse RC, Bouvy ML, de Vries TW, Kaptein AA, Geers HC, van Dijk L, et al. mHealth intervention to support asthma self-management in adolescents: the ADAPT study. Patient Prefer Adherence. 2017;11:571-577. https://doi.org/10.2147/PPA.S124615
6. Farzandipour M, Nabovati E, Sharif R, Arani MH, Anvari S. Patient Self-Management of Asthma Using Mobile Health Applications: A Systematic Review of the Functionalities and Effects. Appl Clin Inform. 2017;8(4):1068-1081. https://doi.org/10.4338/ACI-2017-07-R-0116
7. Franzmair J, Diesner-Treiber SC, Voitl JJM, Voitl P. Effective German and English Language mHealth Apps for Self-management of Bronchial Asthma in Children and Adolescents: Comparison Study. JMIR Mhealth Uhealth. 2021;9(5):e24907. https://doi.org/10.2196/24907
8. Vilarinho T, Floch J, Stav E. Co-designing a mHealth Application for Self-management of Cystic Fibrosis. Proceedings of the 16th 16th IFIP TC 13 International Conference Part III; 2017 Sep 25-29; Mumbai, India. New York: Springer. FIP Conference on Human-Computer Interaction (INTER-ACT). Sep 2017, Mumbai, India. p.3-22. https://doi.org/10.1007/978-3-319-67687-6_1
9. Klok T, Kaptein AA, Brand PLP. Non-adherence in children with asthma reviewed: The need for improvement of asthma care and medical education. Pediatr Allergy Immunol. 2015;26(3):197-205. https://doi.org/10.1111/pai.12362
10. Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. Health Info Libr J. 2009;26(2):91-108. https://doi.org/10.1111/j.1471-1842.2009.00848.x
11. Social Care Institute for Excellence (SCIE) [homepage on the Internet]. Egham, UK: SCIE [updated 2009]. Clapton J, Rutter D, Shariff N. SCIE Systematic mapping guidance. Available from: https://www.scie.org.uk/almost-there
12. Fernández-Sotos P, Torio I, Fernández-Caballero A, Navarro E, González P, Dompablo M, et al. Social cognition remediation interventions: A systematic mapping review. PLoS One. 2019;14(6):e0218720. https://doi.org/10.1371/journal.pone.0218720
13. Davis SR, Peters D, Cavo RA, Sawyer SM, Foster JM, Smith L. "Kiss myAsthma": Using a participatory design approach to develop a self-management app with young people with asthma. J Asthma. 2018;55(9):1018-1027. https://doi.org/10.1080/02770903.2017.1388391
14. Rutland SB, Bergquist RP, Hager A, Geurs R, Mims C, Gutierrez HH, et al. A Mobile Health Platform for Self-Management of Pediatric Cystic Fibrosis: Qualitative Study of Adaptation to Stakeholder Needs and Integration in Clinical Settings. JMIR Form Res. 2021;5(1):e19413. https://doi.org/10.2196/19413
15. Hsia BC, Singh AK, Njeze O, Cosar E, Mowrey WB, Feldman J, et al. Developing and evaluating ASTHMAXcel adventures: A novel gamified mobile application for pediatric patients with asthma. Ann Allergy Asthma Immunol. 2020;125(5):581-588. https://doi.org/10.1016/j.anai.2020.07.018
16. Calvo-Lerma J, Martinez-Jimenez CP, Lázaro-Ramos JP, Andrés A, Crespo-Escobar P, Stav E, et al. Innovative approach for self-management and social welfare of children with cystic fibrosis in Europe: development, validation and implementation of an mHealth tool (MyCyFAPP). BMJ Open. 2017;7(3):e014931. https://doi.org/10.1136/bmjopen-2016-014931
17. Bajis D, Chaar B, Basheti I, Moles R. Teaching asthma first aid to pharmacy students: A comparative study between an online course and simulation by role-play. Pharm Educ. 2021; 21(1):92-104. https://doi.org/10.46542/pe.2021.211.92104
18. Versteegh LA, Chang AB, Chirgwin S, Tenorio FP, Wilson CA, McCallum GB. Multi-lingual "Asthma APP" improves health knowledge of asthma among Australian First Nations carers of children with asthma. Front Pediatr. 2022;10:925189. https://doi.org/10.3389/fped.2022.925189
19. Harte R, Glynn L, Rodriguez-Molinero A, Baker PM, Scharf T, Quinlan LR, et al. A Human-Centered Design Methodology to Enhance the Usability, Human Factors, and User Experience of Connected Health Systems: A Three-Phase Methodology. JMIR Hum Factors. 2017;4(1):e8. https://doi.org/10.2196/humanfactors.5443
20. Calvo-Lerma J, Boon M, Hulst J, Colombo C, Asseiceira I, Garriga M, et al. Change in Nutrient and Dietary Intake in European Children with Cystic Fibrosis after a 6-Month Intervention with a Self-Management mHealth Tool. Nutrients. 2021;13(6):1801. https://doi.org/10.3390/nu13061801