Using *m*-health apps in oncology

A review from 2015 to 2022

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Abstract — **The increased use of smartphones and the COVID-19 pandemic directly influenced the development of remote tools in several areas. In the context of oncology, it was no different, as several studies address health care or services related to mobile devices. Apps aimed at the medical field (*m*-health) focus directly on monitoring symptoms and improving interaction between health professionals and patients, combined with the convenience of smartphones. In this context, this work aims to address recent studies on the use of *m*-health in the clinical practice of oncological diseases and report the characteristics of the apps involved. For this, a review of *m*-health focused on oncology was conducted using the PubMed and Science Direct databases. The investigation was carried out using tools inherent in international databases and was limited to articles published between 2015 and 2022. In total, 34 articles were analyzed, with a higher frequency of publications between 2019 and 2022. The resources observed were patient follow-up, prevention of signs and symptoms, monitoring of treatment and aid in prognosis and diagnosis of patients. It is concluded that a close collaboration among patients, health professionals, and information technology professionals is necessary to optimize symptom recognition and improve patient-professional communication. Although the pandemic has intensified the increase in the use of *m*-health, its use is expected to increase in the post-pandemic scenario, bearing in mind the changes in social dynamics and the growing dissemination of technologies.**

Keywords - m-health; mobile apps; oncology; cancer patients.

I. INTRODUCTION

In response to the COVID-19 pandemic, there has been a fast growth and large number of publications in telehealth applications such as smart/collaborative health technologies and the use of mobile apps for clinical and *m*-health use [1], sustained in the post-pandemic environment. In this context, *m*-health can be used to monitor symptoms and supervise the treatment of cancer patients, in addition to improving doctor-patient communication [2], [3]. The rapid development of these ancillary features and the need for remote patient care and follow-up have resulted in the use of a wide variety of mobile applications in cancer care for screening, diagnostic, therapeutic, and educational purposes [4].

Involving patients and caregivers in the collection of symptoms through *m*-health apps has several benefits, particularly related to early detection of adverse events, which, if triggered, can prevent unnecessary hospital visits [4]. Studies have found that using patient self-assessments prior to a clinical review increases the frequency and quality of these holistic assessments, allowing clinicians to more accurately identify symptoms and make diagnoses [5], [6]. Furthermore, allowing people with cancer to self-manage their symptoms and quality of life may result in more informed and autonomous patients who are partners in their own care, which can consequently reduce the burden on health services by minimizing unnecessary hospital care[6].

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Exploring practical aspects related to remote monitoring is equally important to ensure that care is safe and effective and that patients feel comfortable with this type of approach. Research on nurses' perspectives on telemonitoring found that developing a strong nurse-patient relationship improved patient outcomes by complementing standard care [7].

On the academic side, the evaluation of existing health applications and the development of new *m*-health are fundamental for the improvement of oncological treatment methods and in medical practice in general. Taking this information into account, the present work consists of a review of the literature on recent studies (2015-2022) on mobile applications related to health (*m*-health) in the clinical practice of oncological diseases and on the cataloging of the main characteristics of the applications developed in the cited studies.

II. Review Method

The methodology of this review aims to synthesize the information available in the literature on *m*-health applications in the context of oncological diseases. The guidelines for the review were divided into three stages: planning, search methodology, and interpretation of results, according to the protocol by [8].

The planning section consisted of preparing the research questions, defining the inclusion and exclusion criteria, and the preliminary survey to verify the different approaches to *m*-health in the context of the theme. The search stage involved choosing the databases used to search for publications, structuring the search string, evaluating the quality of the study, and analyzing the data. Finally, results interpretation is performed considering the quality criteria of the publications found and the final selection of relevant publications for the review [8].

A. Criteria for the selection of articles

In the first phase, preliminary research was carried out using some review articles on *m*-health in the oncological context to collect the necessary information for structuring the research questions [2], [9]. After this step, three research questions (RQ) were defined to guide the search and select the most relevant information, as described in Table 1.

TABLE I. Research questions for the review of oncological *m*-health apps.

Research questions
RQ1. What are the main features of the *m*-health apps?
RQ2. Which public target is prioritized in the development of *m*-health?
RQ3. What is the impact of *m*-health applications according to the results in the literature?

Once the RQs were defined, the inclusion (IC) and exclusion (EC) criteria were established in order to prepare the guidelines for searching the studies. IC and EC are listed in Table 2.

TABLE II. Inclusion and exclusion criteria for the review of oncological *m*-health apps.

Inclusion criteria	**Exclusion criteria**
IC1. Studies about *m*-health apps published between 2015-2022	EC1. *m*-health apps for non-oncological pathologies and symptoms
IC2. *m*-health apps used in empirical research and case studies	EC2. Studies involving the use of other virtual devices (e.g. web pages).
IC3. *m*-health applications aimed at the diagnosis, prognosis, monitoring and treatment of cancer patients	EC3. Duplicate studies
IC4. Research articles and case reports written in English	EC4. Literature review articles, short communications, and technical reports

The search was carried out in May 2022 in the international databases such as PubMed and Scopus (Elsevier). The search was limited to academic articles published between 2015 and 2022. The string structure "("*m*-health" OR "mhealth") AND (cancer OR oncology) AND ("application" OR "app" OR ") was used for the search. Afterwards, the records obtained were subjected to bibliometric analysis using the Bibliometrix tool associated with R Studio [10]. This selection considered criteria such as title, abstract, keywords, and relevance for review, in which the duplicate contributions were automatically deleted.

The articles selected and added to the final stage of the review were classified according to their functionality (Prognosis/diagnosis, Treatment, Follow-up and Prevention), target users (oncology patients, physicians/specialists, and general public), and year of publication of the study.

III. Results

The first search resulted in a total of 2480 articles distributed between 1918 Scopus (Elsevier) records and 562 PubMed records. Indeed, Figure 1 graphically shows the growing trend of *m*-health applications in the academic context, between 2015 and 2022, showing the greater interest in using them in oncological context. Afterwards, all these references were loaded and analyzed through the Bibliometrix tool, in which 1755 articles were excluded based on the EC criteria (Table 2). In the next step, the articles were evaluated by title, keywords, and abstracts based on the IC criteria (Table 2), in which 5 duplicates were identified. Thus, 631 articles were selected for meeting the requirements. The remaining articles were read in detail and accepted considering the quality parameters. Fig 1 graphically shows the growing trend of *m*-health applications in the academic context. Fig. 2 summarizes in detail the search methodology steps for the literature review.

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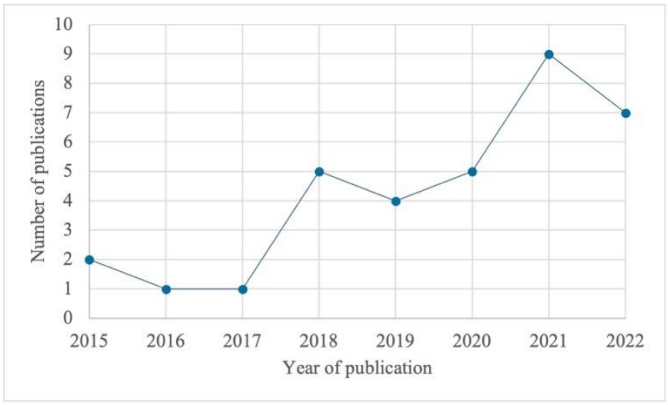

Figure 1. Records of studies published on *m*-health applications in oncology between 2015 and 2022.

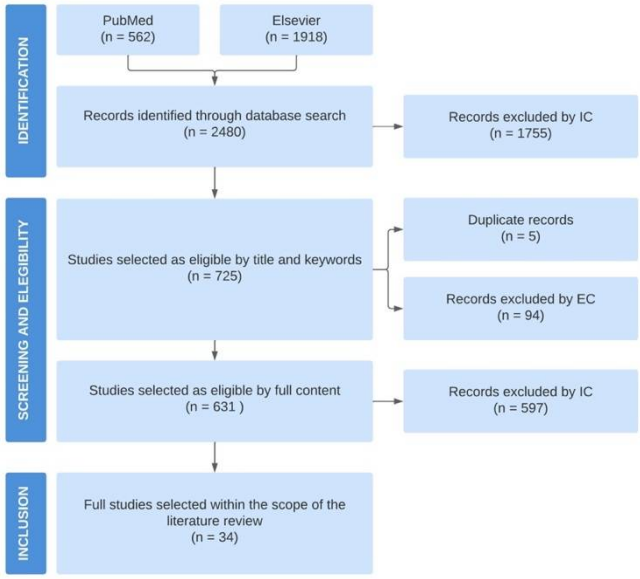

Figure 2. Flow diagram of the search methodology literature review.

The 34 articles selected at the stage of inclusion in the literature review were analyzed and categorized based on the year of publication of the study, general characteristics and target users. The main features of each *m*-health application were identified, as well as the presence or absence of a name.

Reference	**App Name**	**Functionality**	**Target users**
[11]	Oncogrid	Symptom Prevention, Prognosis/Diagnosis, Treatment	General public
[12]	LoseIt!	Follow-up	Oncological Patients
[13]	Pain Buddy	Symptom Prevention, Treatment, Follow-up	Doctors/Specialists
[14]	Happy	Symptom Prevention, Prognosis/Diagnosis	General public
[15]	*	Symptom Prevention, Follow-up	Oncological Patients
[16]	MONTE	Treatment, Follow-up	Oncological Patients, Doctors/Specialists
[17]	Smart After Care	Symptom Prevention, Follow-up	Oncological Patients, Doctors/Specialists
[15]	*	Symptom Prevention, Follow-up	Oncological Patients, Doctors/Specialists
[18]	MyPace	Treatment, Follow-up	Oncological Patients, Doctors/Specialists
[19]	mAGIC	Symptom Prevention, Prognosis/Diagnosis	Oncological Patients
[20]	Pink Journey	Follow-up	Oncological Patients
[21]	Go-Breath	Symptom Prevention, Follow-up	Oncological Patients, Doctors/Specialists
[22]	QuitIT	Symptom Prevention, Follow-up	Oncological Patients
[23]	Interaktor	Symptom Prevention, Treatment, Follow-up	Oncological Patients, Doctors/Specialists
[24]	BENECA	Symptom Prevention, Follow-up	Oncological Patients
[25]	PHAITH	Symptom Prevention, Treatment	Oncological Patients, Doctors/Specialists
[26]	OWise Breast Cancer	Follow-up	Oncological Patients
[27]	Pain Squad	Symptom Prevention, Follow-up	Oncological Patients, Doctors/Specialists

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[28]	*	Symptom Prevention, Follow-up	Oncological Patients
[29]	Color Me Healthy	Treatment, Follow-up	Oncological Patients
[30]	mPCST-Community	Symptom Prevention	Oncological Patients, Doctors/Specialists
[31]	Zamplo	Symptom Prevention	Oncological Patients, Doctors/Specialists
[32]	IMPACT	Symptom Prevention, Follow-up	Oncological Patients
[33]	TRU-BMT	Symptom Prevention, Treatment, Follow-up	Oncological Patients, Doctors/Specialists
[34]	CanRelax	Symptom Prevention, Follow-up	Oncological Patients
[35]	AYA STEP	Symptom Prevention, Treatment, Follow-up	Oncological Patients, Doctors/Specialists
[36]	WeChat Mini Program	Symptom Prevention, Treatment, Follow-up	General public
[37]	Cook and Move for Your Life (CMFYL)	Treatment, Follow-up	Oncological Patients
[38]	GO-EXCAP	Symptom Prevention	Oncological Patients
[39]	*	Symptom Prevention, Treatment, Follow-up	Oncological Patients, Doctors/Specialists
[40]	MobiMD	Symptom Prevention, Treatment. Follow-up	Oncological Patients, Doctors/Specialists
[41]	Health-4-Families	Symptom Prevention, Follow-up	Oncological Patients
[42]	iCanCope	Symptom Prevention, Follow-up	Oncological Patients, Doctors/Specialists

* Unnamed apps.

IV. Discussion

This review evaluates 34 mobile applications aimed at patients with any type of cancer, as shown in Table 1, in which 1.8% of the evaluated studies were published in a pandemic and post-pandemic context, between 2020 and 2022. This suggests that remote medical care due to social distancing during the pandemic may have driven the creation of new applications. However, the functionality and quality of cancer apps vary according to their goals.

Information about the main features was extracted from the content of published articles, which were listed in 4 categories (Symptom Prevention, Prognosis/Diagnosis, Treatment and Follow-up). Most of the *m*-health cataloged have resources for preventing symptoms (26), monitoring (26), and treatments (13), with only three apps are designed to help with the diagnosis and prognosis of patients. It is worth mentioning that most of the studies fit into more than one category. A cross-cutting feature of all apps is connectivity to a webpage to support data collected from patients' mobile devices.

Regarding the type of cancer, most applications were developed for a specific type of cancer, although they allow use for cancer patients in general. However, the target users were analyzed based on the functionalities aimed at patients; doctors; and the general public (not necessarily patients or specialists in oncology). Apps focused on the general public have information resources aimed at helping with the diagnosis and monitoring of symptoms [11], [14], [19]. However, most focus on supporting treatment and alleviating symptoms through the exchange of information between the patient and the physician. Information about the patient's well-being is provided by the patient himself, through data entered into the application and accessed by physicians and caregivers in real time.

Despite the large number of apps aimed at adults, 6 apps were developed for use with pediatric oncology populations to improve symptom reporting and improve communication between the child and the doctor, given the complex emotional and informational needs that this age group carries, in addition to the difficulties of symptom management by parents and caregivers [13], [25], [27], [30], [36], [38].

It is important to emphasize that this review work has limitations, as there are several other *m*-health used for diseases that also fit the oncological context but were not listed in this work, either due to sensitivity to the search factors or because they are completely commercial (not listed in academic databases).

V. Conclusions

In recent years, there has been significant growth in mobile health applications as the clinical and hospital environment is more open to the use of mobile technologies and self-monitoring, especially in the context of a pandemic. It is evident that there are many applications for cancer patients, but most of the applications developed in the academic field are directed at a single type of cancer. More comprehensive applications can be an interesting approach that has the potential to refine clinical paths, improve treatment, and increase the efficiency of

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hospital resources, allowing more proactive care to be provided and its use to be applied in several areas simultaneously.

Despite the large number of studies on *m*-health in cancer, long-term research is needed to explore the feasibility and practicality of integrating existing applications in the treatment of cancer patients. Collaboration with existing application software designers, patients, and oncology teams has proven to be a priority for the development of increasingly useful, safe and innovative applications.

Technology-based solutions have been shown to help strengthen the relationship and communication between patients and their physicians. Furthermore, the patient's symptoms report and access by the medical team can allow subtle changes to be detected, even when consultations are being carried out remotely.

Despite the numerous advantages of using technologies for remote monitoring, some studies demonstrated that a significant number of patients are resistant to this approach, which can be explained by a feeling of isolation, a lack of involvement from the clinical team, and the loss of relevant information for treatment. Therefore, the use of intuitive mobile applications in oncology health services should be a complementary tool and not replace existing systems or justify negligent behavior.

Future studies should focus on comparing care and follow-up in outpatient and inpatient settings with and without the aid of mobile health applications, as well as the impacts from physicians' and cancer patients' perspectives. Furthermore, the effectiveness of the apps should be explored for each type of cancer.

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