

# CUIDADO É FUNDAMENTAL

Escola de Enfermagem Alfredo Pinto – UNIRIO

RESEARCH

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## MOBILE APPLICATIONS TO FIGHT TUBERCULOSIS: A TECHNOLOGICAL PROSPECT

*Aplicativos móveis para enfrentamento da tuberculose: uma prospecção tecnológica**Aplicaciones móviles para combatir la tuberculosis: una perspectiva tecnológica***Mariana Mendes<sup>1</sup>** **Juliana Silveira Bordignon<sup>1</sup>** **Bruna Coelho<sup>1</sup>** **Franciely Daiana Engel<sup>1</sup>** **Francis Solange Vieira Tourinho<sup>1</sup>** 

### ABSTRACT

**Objective:** to identify the mobile applications available for tuberculosis monitoring and their contribution to its combat. **Method:** diagnostic prospection, performed with search on the App Store® and Google Play Store® platforms. The data collection was conducted on April 2021, using the terms “Tuberculose”, “Tuberculosis” and “Tuberculosis”, in Portuguese, English and Spanish. The extraction, organization and tabulation of data was done through Microsoft Excel® 2016. **Results:** The search resulted in 24 apps from the App Store® and 510 from the Google Play Store®. After applying the inclusion and exclusion criteria, 42 apps were analyzed and categorized into general public-oriented apps and healthcare professional information-oriented apps. **Conclusion:** The prospection allowed us to know the state of art of the applications for tuberculosis, identifying the importance of the interactive interfaces, the reminders for proper use of medications and spaces for frequent questions and exchange of experiences.

**DESCRIPTORS:** Tuberculosis; Mobile applications; Biomedical technology; Nursing.

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## RESUMO

**Objetivo:** identificar aplicativos móveis disponíveis para monitoramento da tuberculose e suas contribuições para o seu enfrentamento. **Método:** prospecção diagnóstica, realizada com busca nas plataformas *App Store*® e *Google Play Store*®. A coleta de dados ocorreu em abril de 2021, utilizando os termos “Tuberculose”, “*Tuberculosis*” e “*Tuberculosis*”, em português, espanhol e inglês. A extração, organização e tabulação dos dados foi por meio da ferramenta *Microsoft Excel*® 2016. **Resultados:** a busca resultou em 24 aplicativos na *App Store*® e 510 na *Google Play Store*®. Após aplicação dos critérios de inclusão e exclusão, 42 aplicativos foram analisados e categorizados em aplicativos voltados ao público geral e aplicativos voltados para informações aos profissionais de saúde. **Conclusão:** a prospecção possibilitou conhecer o estado da arte dos aplicativos para tuberculose, identificando-se a importância da interatividade das interfaces, dos recursos de lembretes para uso adequado das medicações e dos espaços para dúvidas frequentes e troca de experiências.

**DESCRITORES:** Tuberculose; Aplicativos móveis; Tecnologia biomédica; Enfermagem.

## RESUMEN

**Objetivo:** identificar las aplicaciones móviles disponibles para el seguimiento de la tuberculosis y sus aportes para combatirla. **Método:** prospección diagnóstica, realizada con búsqueda en las plataformas *App Store*® y *Google Play Store*®. La recolección de datos ocurrió en abril de 2021, utilizando los términos “Tuberculose”, “*Tuberculosis*” y “*Tuberculosis*”, en portugués, español e inglés. La extracción, organización y tabulación de los datos se realizó mediante la herramienta *Microsoft Excel*® 2016. **Resultados:** la búsqueda arrojó 24 aplicaciones en *App Store*® y 510 en *Google Play Store*®. Después de aplicar los criterios de inclusión y exclusión, se analizaron 42 aplicaciones y se clasificaron en aplicaciones dirigidas al público en general y aplicaciones destinadas a brindar información a los profesionales de la salud. **Conclusión:** la prospección permitió conocer el estado del arte de las aplicaciones para la tuberculosis, identificando la importancia de la interactividad de las interfaces, de los recursos de recordatorios para el uso adecuado de los medicamentos y de los espacios de dudas frecuentes e intercambio de experiencias.

**DESCRIPTORES:** Tuberculosis; Aplicaciones móviles; Tecnología biomédica; Enfermería.

## INTRODUCTION

Tuberculosis (TB) is an infectious disease caused by *Mycobacterium Tuberculosis*, also known as Koch’s bacillus, which usually affects the lungs. Its transmission occurs through respiratory route when an individual contaminated by the bacillus releases aerosols by coughing, speaking, or sneezing.<sup>1</sup>

In 2019, globally, 10 million people fell ill and 1.2 million people died as a result of TB.<sup>1</sup> In the same year, Brazil registered about 4.5 thousand deaths, and in 2020, about 66,819 new cases of the disease were registered in the country. However, the Ministry of Health (MS) warns that these numbers may be even higher due to the reduction in the number of notifications at all levels of care during the pandemic of Covid-19.<sup>2</sup>

Prevention, diagnosis, and early treatment are fundamental to heal infected patients and prevent the transmission of the disease. For this, strategies to combat TB must guarantee free access to treatment, isolation of patients in transmission phase, and drug use monitoring.<sup>1</sup> Literature highlights the association between the incidence of tuberculosis and variables related to the dimensions of living conditions, such as household goods, housing and surroundings’ conditions, population density, and income distribution.<sup>3</sup>

The main barriers to treatment agreement are related to the minimum six-month treatment period, the daily use of medicines, the side effects caused by the drugs, socioeconomic and cultural

factors of the individuals.<sup>4</sup> The adherence to the treatment of TB is a global challenge, therapy interruptions can lead to the worsening of the disease and the development of drug-resistant bacteria.<sup>1-4</sup>

Therefore, several strategies have been developed by the World Health Organization (WHO) and Member States to combat TB worldwide. For example, the 2015 Global Task Force on digital health, which encourages the use of Information and Communication Technologies (ICTs) to assist in the prevention, care, and control of TB.

The use of resources such as Electronic Health (e-Health) and Mobile Health (m-Health), known as e-health and m-Health respectively, have been seen by WHO as potentially assisting in the fight against TB. The use of mobile messaging such as reminders and voice calls has demonstrated that incorporating these features into traditional care can improve patient agreement with clinic visits for diagnosis and treatment.<sup>5-6</sup> However, more studies are needed to support evidence on possible benefits related to individualized dosage, patient education and diagnosis.<sup>4</sup>

Technological prospecting studies are a powerful instrument to direct the development of new technologies. Such studies evaluate the existence of gaps or saturation in relation to products already available in the market. Thus, the importance of these studies is determined since they allow the appreciation of patenting trends of mobile applications, in addition to elaborate subsidies in the technological field to expand innovation studies in health.<sup>7</sup>

The potential use of ICT in e-Health and m-Health systems in the combat of TB constitutes fertile ground for new research, in order to maximize its effects based on robust scientific evidence. These can support the decision-making of managers and health professionals and expand the possibilities of safe and quality health practices.

Thus, this technological prospection of mobile applications on the prevention, diagnosis and treatment of TB offers possibilities to contribute with healthcare practices and the development of technologies that meet the health needs of users and professionals involved in the management of the disease. Technological prospection as a research tool makes it possible to map the existing technologies and identify points of improvement for the creation of new tools.<sup>8</sup> Moreover, it has the potential to provide results that allow reflection on the use, possible benefits and challenges of m-Health and its relation to the worldwide fight against the TB epidemic.

Based on this background, the following questions are raised: “What mobile applications are available to provide information on TB?” and “What are the contributions of the existing mobile applications to the prevention, diagnosis and treatment of TB?” To answer these questions, these research aims to identify the mobile applications available for TB monitoring and their contributions to the fight against TB.

## METHOD

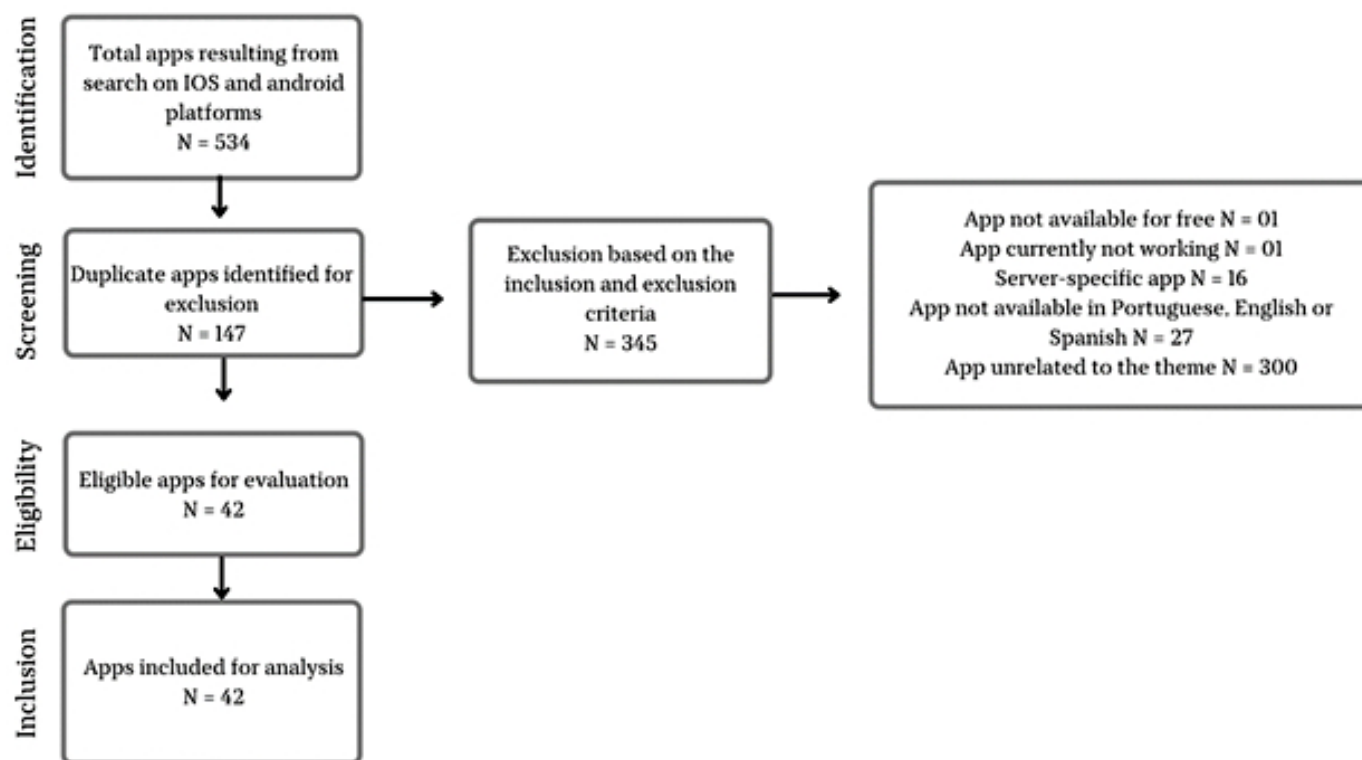
### Study design

This is a technological prospection study, used as a research tool to enable the mapping of existing technologies and to identify improvement points for the creation of new tools.<sup>8</sup> In this technological prospection of mobile applications on the prevention, diagnosis and treatment of TB, possibilities are sought to contribute to this debate, providing a potential for obtaining results that allow reflection on the use, possible benefits and challenges of m-Health and its relationship with the global fight against the TB epidemic.

### Source and data collection

The research was conducted through search in the IOS App Store® and Android platforms in the Google Play Store®. Data collection was performed on April 2021, using the terms “Tuberculose”, “Tuberculosis” and “Tuberculosis”, in Portuguese, English and Spanish, respectively.

The inclusion criteria were: a) applications focused on TB information; b) free access; c) available in Portuguese, English and/or Spanish. Applications that were unrelated to the theme, available only to servers of public or private institutions, and duplicates were excluded (Figure 1).



**Figure 1** – Flowchart of the selection of the applications. Florianopolis, SC, Brazil, 2021. Source: The authors, 2021.

## Data organization and analysis

Data extraction, organization, and tabulation were performed using Microsoft Excel® 2016. The following information was extracted: name of the application, indicative rating (age indicated for use of the application), category determined by the platform (medicine, health, fitness, among others), application's year of development, main language of the application, user ratings, and application description.

The data were grouped into two analytical categories, according to the description and purpose of the applications: information for the general public and information for health professionals. The mobile applications were also classified according to the type of information that is offered to the target audience, as follows: (a) general information on tuberculosis; (b) information on disease prevention; (c) information regarding tuberculosis treatment; (d) information on diagnosis; (e) orientation on the calculation of medication for the treatment of tuberculosis; (f) medication administration reminder tool; (g) information on medication side effects; (h) diet information; i) tuberculosis epidemiology; j) tuberculosis manuals and guidelines; k) information on tuberculosis in association with the human immunodeficiency virus; l) illustrative information content; m) training opportunities; n) information on international events; o) information on the risk of tuberculosis infection; and p) applications that have user interaction.

## RESULTS

The search resulted in 24 applications from the App Store® and 510 from the Google Play Store®. After applying the inclusion and exclusion criteria, 42 apps were included for final analysis, identified in Chart 1.

Of the 42 apps identified and analyzed, 25 were found only in the Android platform, ten only in IOS, and seven were common

on both platforms. Regarding the app's rating, on the IOS platform, no app had a rating note provided by users; on the Android platform, of the 25 apps, 13 did not contain this information.

Regarding the age classification for the use of apps, we noticed that 73.8% (n=31) have a free classification, followed by the apps recommended for users over 17 years old, with 9.5% (n=04).

As for the application category, 47.6% (n=20) are classified as medicine, 33.3% (n=14) as health and fitness, followed by educational apps with 14.3% (n=06), and the smallest quantity corresponds to apps classified as books and references with 4.8% (n=02). It is noteworthy that in the books and references category the apps found in the search are not characterized as books, one of which seeks to inform users about TB in general, where it is not possible to identify the origin of the information, while the other app deals with reporting epidemiological data of the disease based on WHO statistics.

In relation to the development year of the applications, there is a range from 2012 to 2021, with the year 2020 standing out, in which 26.2% (n=11) of the total applications were made available. The years 2012, 2015, and 2016 represented the lowest quantity of applications, with only two in each year. Of the total number of applications selected, two did not have information about the development year.

As for the language of the application, there was a predominance of those available in English and Spanish, corresponding to 56.2% (n=41) and 6.8% (n=05), respectively. The languages Portuguese, French, Italian were available in three applications, German in two, and the others with only one application, being: Armenian, simplified Chinese, Estonian, Georgian, Romanian, Russian, Serbian, Ukrainian, Arabic, Croatian and Lithuanian. The diversity of languages presupposes the expansion of access to applications; however, it is noteworthy the reduced number of contents in Portuguese.

**Chart 1** – Characterization of applications per platform according to platforms, denomination, classification by age, category, year of development, name of developer, target audience and type of information, 2021

Name of the App	Category	Year*	Classification Rating **	Developer	Target Audience	Information Type
<b>Android Platform</b>						
Tuberculosis – TB Treatment and Plan	Health & Fitness	2018	Free	Tech Soln	General	a) general information on tuberculosis b) information regarding prevention of the disease c) information regarding tuberculosis treatment d) information on diagnosis
Tuberculosis: Causes, Diagnosis, and Management	Medicine	2018	Free	Helth info	General	a) general information on tuberculosis c) information regarding tuberculosis treatment d) information on diagnosis
Tuberculosis TB Symptoms Causes & Diet Help	Health & Fitness	2017	Free	Kaveri Tyagi	General	a) general information on tuberculosis b) information regarding prevention of the disease c) information regarding tuberculosis treatment h) diet information
Tuberculosis Disease	Medicine	2018	Free	Popularp	General	a) general information on tuberculosis c) information regarding tuberculosis treatment

Chart 1 – Cont.

Name of the App	Category	Year*	Classification Rating **	Developer	Target Audience	Information Type
Tuberculosis Cure & Treatment	Medicine	2020	Free	Fumo	General	a) general information on tuberculosis b) information regarding prevention of the disease c) information regarding tuberculosis treatment i) tuberculosis epidemiology
Tuberculosis	Medicine	2017	Free	Helth Care Tips Information	General	a) general information on tuberculosis
Tuberculosis	Medicine	2018	Free	Almanacsoft	Professional	d) information about the diagnosis
Medical Management of MDR-TB	Medicine	2015	Free	ConstantOdds	Professional	c) information regarding tuberculosis treatment e) guidance on medication calculation for tuberculosis treatment
Care TB	Health & Fitness	2020	Free	DOH – KMITS	General	c) information regarding tuberculosis treatment p) application that interacts with the user
Guide TB	Health & Fitness	2020	Free	DOH – KMITS	Professional	j) manuals and guidelines on tuberculosis
Race TB	Health & Fitness	2020	Free	DOH – KMITS	Professional	i) epidemiology of tuberculosis
N-TB	Health & Fitness	2018	Free	Center of Nutrition Studies Yenepoya	Professional	h) diet information
Nursing DR-TB Guide	Health & Fitness	2020	Free	International Council of Nurses	Professional	c) information regarding tuberculosis treatment g) information on side effects of medication
TB Doctor	Medicine	2016	Free	Dr Rohan S.Navelkar	General & Professional	c) information regarding tuberculosis treatment g) information on side effects of medication
Home Remedies for Tuberculosis	Health & Fitness	2020	Free	Seedlings Inc	General	a) general information on tuberculosis c) information regarding tuberculosis treatment
Tuberculosis Disease-causes, diagnosis, treatment	Books & References	2021	Free	Health Bytes	General	a) general information on tuberculosis c) information regarding tuberculosis treatment d) information on diagnosis
Natural Remedies for tuberculosis (TB)	Health & Fitness	2020	Free	FingertipApps	General	a) general information on tuberculosis c) information regarding tuberculosis treatment d) information on diagnosis
Tuberculosis TB home remedies	Health & Fitness	2017	Free	StatesApps	General	c) information regarding tuberculosis treatment
TB Mitra	Health & Fitness	2018	Free	Dure Technologies	General	a) general information on tuberculosis p) application that has interaction with the user
TuberSpot	Medicine	2015	Free	SpotLab	Professional	d) information on diagnosis
Anti-TB Drugs	Medicine	2016	Free	Dr Rohan S.Navelkar	Professional	c) information regarding tuberculosis treatment
TB Mobile	Education	2012	Free	CDD	Professional	c) information regarding tuberculosis treatment
Hataima Swasthya	Education	2020	Free	Save the Children, Nepal	General	a) general information on tuberculosis c) information regarding tuberculosis treatment f) medication reminder tool k) information on tuberculosis in association with the human immunodeficiency virus
The Compendium – Who	Medicine	2018	Free	Global Innovative Service, Inc	Professional	j) manuals and guidelines on tuberculosis
WashKaro – TB	Health & Fitness	2020	Free	TavLab	General	a) general information on tuberculosis p) application that has interaction with the user

Chart 1 – Cont.

Name of the App	Category	Year*	Classification Rating **	Developer	Target Audience	Information Type
<b>IOS Platform</b>						
CII4TBFree	Health & Fitness	2020	> 04 years	Confederation of Indian Industry (CII)	General	a) general information on tuberculosis
TB Indonesia dashboard	Education	2021	> 12 years	Novan Hartadi Information	Professional	i) epidemiology of tuberculosis
The Compendium	Medicine	2018	> 17 years	GISVCS	Professional	j) manuals and guidelines on tuberculosis
Bronquiectasias – SEPAR	Health & Fitness	2019	> 04 years	SEPAR	Professional	c) information regarding tuberculosis treatment d) information on diagnosis
50ª Conferência Mundial da União	Medicine	NA	> 12 years	International union tuberculosis respiratory disease	Professional	a) general information on tuberculosis n) information on international events
SNTC	Medicine	2012	> 17 years	University of Florida	Professional	a) general information about tuberculosis m) training opportunities
COMPASS Save The Children	Education	2019	> 04 years	Save the Children (Sales) Ltd	Professional	j) manuals and guidelines on tuberculosis k) information on tuberculosis in association with human immunodeficiency virus
The Union Courses Online	Education	2019	> 17 years	E-MED HOSTING. CO M INC. ©	Professional	m) training opportunities
TB Companion	Medicine	2021	> 17 years	German Central Committee for Combating Tuberculosis eV	General	a) general information on tuberculosis c) information regarding tuberculosis treatment d) information on diagnosis
TB Storyteller	Education	NA	> 12 years	ZMQ Technologies Unip. Ltd.	General	a) general information on tuberculosis l) illustrative content of the information
<b>Android &amp; IOS Platforms</b>						
TB Report	Books & References	2019	Free	Adappt Ltd	General	a) general information on tuberculosis i) epidemiology of tuberculosis
Explain TB	Medicine	2018	Free	Explain TB	General	a) general information on tuberculosis
TBeReview:DRTB Classificação	Medicine	2017	Free	Global Innovative Service, Inc	Professional	c) information regarding tuberculosis treatment d) information on diagnosis
TBeReview:HIVT B	Medicine	2017	Free	Global Innovative Service, Inc	Professional	c) information regarding tuberculosis treatment d) information on diagnosis k) information on tuberculosis in association with human immunodeficiency virus
Life4me+	Medicine	2017	Free	Life4me.plus	General	a) general information on tuberculosis k) information on tuberculosis in association with human immunodeficiency virus
Global Forum on TB Vaccines	Medicine	2021	Free	All In the Loop Information	Professional	n) information on international events
Riskradar	Medicine	2020	> 10 years	eHealth Lab   INAB-CERTH	General	a) general information on tuberculosis k) information on tuberculosis in association with human immunodeficiency virus o) information on the risk of tuberculosis infection

\* Application's Development Year\*\* Indicative rating for the use of the application

Source: The authors, 2021.



### Application characterization according to the purpose, expressed in the researched bases

In a first group are the applications directed to the general public, with the purpose of providing information to users. Of the total, 37.7% (n=20) contain general information about TB, and one app provides the content through comics.

Regarding TB treatment, 28.3% (n=15) applications address the types of treatment for the disease, with emphasis on five focused on dietary guidelines during treatment, indicating the association of fruits, vegetables and teas with drug treatment. In this case, one application sought to provide information about the side effects of medications used in the treatment and only one had the user reminder of the time for medication administration as a function.

Three applications (5.7%) dealt with ways for preventing TB, one being specifically directed to the risk calculation of TB infection in association with the human immunodeficiency virus (HIV). Only 5.7% (n=03) have user interaction as a function, being two applications through chatbot and one through the report of problems that users face in relation to diagnosis and treatment of the disease.

The second group of apps provides information for health professionals. Of these, most provide guidance on treatment 30% (n=09) and 16.7% (n=5) on TB diagnosis. The contents were related to the calculation of medications and the pathological agent. The approach to TB and HIV was related to general orientations, corresponding to 6.7% (n=02) of the applications, and about the importance of an adequate diet for patients undergoing TB treatment, corresponding to 3.3% (n=01).

Regarding the availability of manuals and guidelines, 13.3% (n=04) had recommendations on the management of the disease, sharing documents such as the Procedures Manual of the National Tuberculosis Control Program from the Philippines and the World Health Organization guidelines. Regarding trainings, 6.7% (n=02) advertised opportunities for refresher courses via Webinar and learning courses on TB.

## DISCUSSION

TB is a chronically evolving infectious disease considered a public health problem and has mobilized health organizations globally. With the rapid advance of technology development, mobile applications have assisted health professionals in the diagnosis of pediatric TB and in the active search performed by community health workers.<sup>9-10</sup>

The findings of this study show the growth of mobile applications for combating TB in 2020, which may have been driven, within the process of growth in the use of digital tools, by the need for distance due to the pandemic of covid-19. It is understood that stimulating the co-participation of patients in their treatment is also a way to encourage self-care, so that applications aimed at health promotion and disease prevention assume relevance in the face of the TB epidemic.

It was identified that most mobile apps focus their information on general aspects of the disease. In this sense, they contribute to the integration of preventive actions and health promotion, with a focus on expanding access to health services and health education actions. The concept of educational-care technology points to the purpose of a new model of conceiving technological products and processes in different practice and health research scenarios.<sup>11</sup>

The use of educational technologies aims to consolidate and qualify care by taking into account the uniqueness of each individual who uses it, helping to fill knowledge gaps and directing to the most effective and safe care. The use of follow-up through mobile applications can support the qualification of care by health professionals and self-care by users, concomitant to cost reduction.<sup>12</sup>

Communication and information through mobile applications can also collaborate in the dynamics of health services. Their functions can reduce or even avoid displacements, condense demands of the health network, mitigate aggravations resulting from the lack of therapeutic support, and favor reference and counterreference.<sup>12</sup>

However, it was found that few mobile apps had features that assist in TB treatment adherence, such as messages in the format of “reminders” at medication times. Still, the proposal of the apps maintains the logic of passive transmission of knowledge in virtual environments with little user interaction in chatbot or shortcuts to frequently asked questions.

From the software effectiveness point of view, it is essential to evaluate certain factors, such as the interface, user communication, and an easy-to-use system, so that the user can follow directions easily.<sup>13</sup> This aspect seems to be weak in the researched applications, which may hinder user interaction and produce few effects regarding treatment adherence and adoption of healthier lifestyles.

In a study conducted in 2016, the effectiveness of cell phone and tablet apps was investigated in the self-management of chronic disease symptoms by encouraging the consumption of a healthy diet with fruits and vegetables and the practice of physical exercises. The results indicated improvement in health conditions of patients living with symptoms of diabetes, cardiovascular disease, and lung disease through changes in lifestyle habits stimulated by the application.<sup>14</sup>

The rise of new mobile health communication technologies has been an important and efficient strategy to encourage patients to adopt healthier lifestyles, to provide disease guidelines, to emphasize self-care for chronic disease conditions, and to decrease the time and cost to the patient and the health care system.<sup>12</sup>

The use of mobile applications in healthcare has become increasingly frequent. They have the potential to qualify health outcomes, especially those directed to patients with chronic diseases, those who use continuous medication or those undergoing prolonged treatment, as in the case of TB patients.

Thus, it is understood that health professionals can use mobile applications to monitor patients under their care, encouraging

an active dialogue also in the remote modality, in line with the necessary longitudinality of care and the bond, from the perspective of integrality. In addition, the training opportunities disseminated by the applications constitute a privileged locus for continuous learning, since professionals can access the content at any place and time.

This study shows the need to develop technological tools that go beyond informing the user through text, which would make it possible to reach a larger number of users through interactive health education functionalities, in which the awakening of knowledge for the empowerment and autonomy over their health occurs.

Still, applications that have user monitoring functions regarding signs, symptoms, side effects and reminders of medication schedules can be better explored by developers, in view of the small number of applications with this applicability, opening ways for better records and control of the user on the progress of their treatment.

The search for equivalent terms can be considered a limitation of the study, resulting in a large number of applications that were not related to the central theme, consisting in an opportunity for new studies that explore other dimensions of investigation about health care applications related to TB.

## CONCLUSIONS

The present study allowed the identification of mobile applications available on Android and iOS digital platforms, developed for globally monitoring and improving TB treatment adherence. This research shows that developers can promote apps with different functionalities, such as those for monitoring and for direct interaction between professionals and users.

Furthermore, improvements in the interface and effectiveness of the applications can favor treatment adherence, facilitate access to services and treatments, as well as obtain a record of the user's health history.

The use of propection allowed us to identify the importance of more interactive interfaces, reminder resources for the proper use of medications, and spaces for frequent questions and exchange of experiences. It is necessary, when developing apps, to invest in resources that promote self-care logic, autonomy, and prevention, reinforcing the commitment to health from the perspective of comprehensive care.

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