PUBLICAÇÃO OFICIAL DO NÚCLEO HOSPITALAR DE EPIDEMIOLOGIA DO HOSPITAL SANTA CRUZ E PROGRAMA
DE PÓS GRADUAÇÃO EM PROMOÇÃO DA SAÚDE - DEPARTAMENTO DE BIOLOGIA E FARMÁCIA DA UNISC

Revista de Epidemiologia e Controle de Infecção

Hospital Santa Cruz

REVIEW ARTICLE

Digital health for treatment adherence in people with tuberculosis: a systematic review

Saúde digital para a adesão ao tratamento da pessoa com tuberculose: uma revisão sistemática

Salud digital para la adherencia al tratamiento en personas con tuberculosis: una revisión sistemática

https://doi.org/10.17058/reci.v13i3.18231

Received: *08/03/2023*
Accepted: *01/04/2023*
Available online: *08/09/2023*

Corresponding Author:
Ariela Fehr Tártaro
ariela.fehr@gmail.com

Address: Avenida dos Bandeirantes, 3900 - Campus Universitário Bairro Monte Alegre - Ribeirão Preto - SP – Brasil

Ariela Fehr Tártaro[1];
Ruan Victor dos Santos Silva[1];
Juliana Soares Tenório de Araújo[1];
Antônio Carlos Vieira Ramos[1];
Thaís Zamboni Berra[1];
Yan Mathias Alves[1];
Maria do Socorro Nantua Evangelista[2];
Miguel Angel Fuentealba-Torres[3];
Ricardo Alexandre Arcêncio[1];

[1] Universidade de São Paulo, Ribeirão Preto, SP, Brazil.
[2] Universidade de Brasília. Brasília, DF – Brazil.
[3] Facultad de Enfermería y Obstetricia - Universidad de Los Andes.

ABSTRACT

Justifications and Objectives: the use of digital health, among people diagnosed with tuberculosis, can be an effective strategy, combined with health services, to increase adherence to treatment and impact the disease's epidemiological data in the country. As this topic has been widely discussed and improved in recent years, it is necessary to further investigate the research available on scientific bases. The objective of this study was to describe the use of digital health technologies to assist with adherence to tuberculosis treatment. **Methods:** this is a systematic literature review with a rapid review approach, following the PRISMA guidelines and the Cochrane guide. Evidence quality was assessed using the Mixed Methods Appraisal Tool. The studies were identified in PubMed, VHL, CINAHL, Cochrane Trial, SciELO, Scopus and Embase. Experimental, quasi-experimental studies and clinical trials were included, without language restrictions, published between 2020 and 2022. **Content:** nine studies were selected, which demonstrated that the implementation of digital technologies improved adherence rates to medication treatment and cure rates. Applications use strategies such as synchronous and asynchronous video, voice calls and text messages. Among the studies, only two technology/application names were mentioned. **Conclusion:** digital technologies have had a positive impact on the treatment of people diagnosed with tuberculosis.

Keywords: *Telemedicine; Tuberculosis; Treatment Adherence and Compliance; Systematic Review.*

RESUMO

Justificativas e Objetivos: a utilização da saúde digital, junto às pessoas diagnosticadas com a tuberculose, pode ser uma estratégia eficaz, aliada dos serviços de saúde, para aumentar a adesão ao tratamento e impactar os dados epidemiológicos da doença no país. Como esse tema tem sido amplamente discutido e aprimorado nos últimos anos, é necessário investigar mais a fundo as pesquisas disponíveis nas bases científicas. O objetivo deste estudo foi descrever o uso de tecnologias em saúde digital para auxiliar na adesão ao tratamento da tuberculose. **Método:**

Please cite this article as: *Tártaro A, dos Santos Silva RV, Soares Tenório de Araújo J, Vieira Ramos AC, Zamboni Berra T, Mathias Alves Y, do Socorro Nantua Evangelista M, Fuentealba-Torres MA, Arcêncio RA. Saúde digital para a adesão ao tratamento da pessoa com tuberculose: uma revisão sistemática. Rev Epidemiol Control Infect [Internet]. 7º de novembro de 2023 [citado 20º de novembro de 2023];13(3). Disponível em: https://online.unisc.br/seer/index.php/epidemiologia/article/view/18231*

Exceto onde especificado diferentemente, a matéria publicada neste periódico é licenciada sob forma de uma licença Creative Commons - Atribuição 4.0 Internacional.
http://creativecommons.org/licenses/by/4.0/

trata-se de revisão sistemática da literatura com abordagem de revisão rápida, seguindo as diretrizes do PRISMA e o guia da Cochrane. A qualidade das evidências foi realizada utilizando a ferramenta *Mixed Methods Appraisal Tool*. Os estudos foram identificados nas bases de dados PubMed, BVS, CINAHL, Cochrane Trial, SciELO, Scopus e Embase. Foram incluídos estudos experimentais, quase-experimentais e ensaios clínicos, sem restrição de idioma, publicados entre 2020 e 2022. **Conteúdo:** foram selecionados nove estudos, que demonstraram que a implementação de tecnologias digitais melhorou as taxas de adesão ao tratamento medicamentoso e as taxas de cura. Os aplicativos utilizam estratégias como vídeo síncrono e assíncrono, chamadas de voz e mensagens de texto. Entre os estudos, apenas dois nomes de tecnologia/aplicativo foram mencionados. **Conclusão:** as tecnologias digitais têm impactado de forma positiva no tratamento das pessoas com diagnóstico de tuberculose.

Descritores: *Telemedicina. Tuberculose. Cooperação e Adesão ao Tratamento. Revisão Sistemática.*

RESUMEN

Justificaciones y objetivos: el uso de la salud digital entre las personas diagnosticadas con tuberculosis puede ser una estrategia eficaz y aliada de los servicios de salud para aumentar la adherencia al tratamiento e impactar los datos epidemiológicos de la enfermedad en el país. 3. **Método:** se realizó una revisión sistemática de la literatura con un enfoque de revisión rápida, siguiendo las pautas de PRISMA y la guía de Cochrane. La calidad de la evidencia se evaluó utilizando la herramienta *Mixed Methods Appraisal Tool*. Los estudios se identificaron en las siguientes bases de datos: PubMed, BVS, CINAHL, Cochrane Trial, SciELO, Scopus y Embase. Se incluyeron estudios experimentales, cuasiexperimentales y ensayos clínicos, sin restricciones de idioma, publicados entre 2020 y 2022. **Contenido:** se seleccionaron nueve estudios que demostraron que la implementación de tecnologías digitales mejoró las tasas de adherencia al tratamiento con medicamentos y las tasas de curación. Las aplicaciones utilizan estrategias como video sincrónico y asincrónico, llamadas de voz y mensajes de texto. Entre los estudios, sólo se mencionaron dos nombres de tecnologías/aplicaciones. Conclusión: las tecnologías digitales han tenido un impacto positivo en el tratamiento de personas diagnosticadas con tuberculosis.

Palabras clave: *Telemedicina; Tuberculosis; Cumplimiento y Adherencia al Tratamiento; Revisión Sistemática.*

INTRODUCTION

Tuberculosis (TB) is a serious global public health problem, affecting vulnerable countries and groups, with an estimated 1/3 of the world's population infected by *Mycobacterium tuberculosis*. To combat the disease, the World Health Organization (WHO) launched the End TB Strategy, based on three pillars: person-centered care; integrated and robust health systems covered by social protection programs; and research and innovation.[1,2]

According to the WHO report released in 2021, in Brazil, only 71% of people diagnosed with TB complete treatment, a rate below the goal established by the WHO of at least 85%.[3] Several factors can influence the decision-making of people with TB, such as socioeconomic aspects, access to health services, social protection actions and lack of information or knowledge about the disease.[4]

TB treatment typically requires daily supervision and use of a combination of medications, which can cause adverse reactions and negatively affect the treatment experience. This can lead to non-adherence or abandonment of treatment.[4,5] Therefore, care focused on sick individuals' well-being, as recommended by person-centered care, is essential for supporting and ensuring the completion of TB treatment.[4]

The introduction of Directly Observed Treatment Short Course (DOTS) substantially increased cure rates and reduced dropouts, being considered a blueprint strategy.[4-6] However, a study developed in 2020 estimates that physical distancing measures contribute to an increase in 6.3 million additional cases of TB between the years 2020 and 2025, in addition to 1.4 million deaths from TB due to the reduction in coverage of TB DOTS strategy.[7]

Even before the COVID-19 pandemic, Video Directly Observed Treatment (VDOT) was already encouraged as an alternative to traditional DOTS, since digital resources are viable and have long reach, minimizing barriers cultural, organizational, economic and geographic issues faced by people with TB.[8,9]

The WHO supports a configuration of the strategy based on digital health, person-centered care and Unique Therapeutic Projects. However, this recommendation still needs to be thoroughly assessed against the strengths of evidence available for advanced DOTS in digital health. Although a systematic review has been observed in the literature, many other studies may have been produced, and a new analysis with more evidence is needed.[10-11] Considering the above, the study aims to describe the use of digital health technologies to assist with adherence to TB treatment through a systematic literature review with a rapid review approach.

METHODS

This is a systematic literature review with a rapid review approach registered in PROSPERO under number

CRD42022364841. The review was conducted according to the Cochrane Handbook for Systematic Reviews of Interventions methodological items, in addition to using the Guidance from the Cochrane Rapid Reviews Methods Group of 2020. The presentation of results was reported in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[12,13]

Studies without language restrictions were included, published between January 1, 2020 and September 15, 2022. The time frame was carried out following the rapid review methodology developed by Cochrane, in cases where there is a need for a rapid synthesis of evidence. This approach simplifies systematic review components, such as limiting search time. Furthermore, the time frame was carried out to identify which technologies are the most recent and which remain up to date.[13]

Quantitative, experimental, quasi-experimental studies and clinical trials were included. The study population was made up of people aged 18 years or over, with all types of TB (pulmonary, extrapulmonary TB, latent TB, active TB, sensitive TB or extrapulmonary TB), as proven by the study analyzed. Technologies included were smartphone apps, synchronous and/or asynchronous videos, phone reminders, ingestible sensors, SMS (Short Message Service) reminders, and other digital health interventions that aim to improve medication adherence and TB treatment outcomes.

The primary outcome was medication adherence, i.e., treatment completion, adherence rate and missed doses. Adherence can be measured through the patient's medical record and/or self-report on the device, through asynchronous or synchronous video, responding to phone calls and SMS text messages. There is no "gold standard" in the literature to measure adherence behavior, as there are a variety of strategies used.[14]

Studies were included, within the eligibility aspects, to address the following question: what is the evidence of use of telemedicine in adherence to TB treatment? The question was formulated following the PIO acronym structure (P = Population, I = Intervention or exposure, O = Outcome) (Chart 1).[15]

The following databases were used for the research: US National Library of Medicine (PubMed); Virtual Health Library (VHL); Cumulative Index to Nursing and Allied Health Literature (CINAHL); Cochrane Trial; Scientific Electronic Library Online (SciELO); Scopus; and Embase.

The search strategies were developed in collaboration with a specialized librarian, using the Boolean operators AND and OR in combination with the Medical Subject Headings (MeSH), Health Sciences Descriptors (DeCS) and Emtree Terms descriptors, in accordance with each database. The general strategy included the descriptors "Tuberculosis" AND "Telemedicine" AND "Treatment Adherence", combined with keywords.

Throughout the text, the term used was "digital health", but in the search term, it was replaced by the synonym "telemedicine", as it is a descriptor considered more appropriate to cover the broad search in databases.[12] It is important to highlight that access to the electronic databases was carried out through the content services (Proxy) of *the Universidade de São Paulo* (USP) - *Campus* Ribeirão Preto via USP's VPN (Virtual Private Network).

Retrieved records were imported into the Rayyan® software,[16] and duplicate records were eliminated. The remaining records were grouped according to titles and abstracts to identify potentially eligible studies. During screening, 24 studies could not be read in full, as they were absent from online platforms, only having their abstracts. E-mails were sent to the authors requesting full access to the article, but there was no response until the completion of this study.

Records' titles and abstracts were assessed by two independent reviewers (AFT, RVSS) and a third reviewer (JSTA) who arbitrated any disagreements. Potentially eligible records were read in full by two independent reviewers (AFT, RVSS), again, with third reviewer (JSTA) refereeing. The study selection process was outlined according to the PRISMA diagram.[12]

Data were collected independently by two reviewers (AFT, RVSS), and all disagreements were discussed by the team until a consensus was reached. A standardized extraction form based on the Cochrane Consumer and Communication Review Group Data Extraction Template (2015) was used. The information extracted included: 1) author; 2) year of publication; 3) country of publication; 4) study design; 5) study objective; 6) sample characteristics; and 7) results.

The Mixed Methods Appraisal Tool (MMAT) assesses according to the percentage of development of each domain, using the descriptor "*", which is equivalent to 25%, with the maximum quality score with 100% development expressed by the descriptor "****". Based on the results found, study quality was classified as "high quality" evidence (100% = "****"), "moderate quality" (75% = "***"); and "low quality" (< 50% = "**"; "*").[17]

According to Resolutions 466/2012 and 510/2016, "all research involving human beings must be assessed

Chart 1. Components of research question according to the acronym "PIO" (P = Population, I = Intervention or exposure, O = Outcome).

Description	Acronym	Search components	Descriptors and keywords
Population	P	Adults diagnosed with TB	Patients AND Tuberculosis OR Mycobacterium tuberculosis
Intervention	I	Telemedicine	Telemedicine OR Connected Health OR Digital Health OR Health Tele-Services OR Mobile Health
Outcome	O	Adherence to TB treatment	Treatment Adherence and Compliance OR Adherence, Therapeutic OR Adherence, Treatment OR Therapeutic Adherence OR Therapeutic Adherence and Compliance

Please cite this article as: *Tártaro A, dos Santos Silva RV, Soares Tenório de Araújo J, Vieira Ramos AC, Zamboni Berra T, Mathias Alves Y, do Socorro Nantua Evangelista M, Fuentealba-Torres MA, Arcêncio RA. Saúde digital para a adesão ao tratamento da pessoa com tuberculose: uma revisão sistemática. Rev Epidemiol Control Infect [Internet]. 7º de novembro de 2023 [citado 20º de novembro de 2023];13(3). Disponível em: https://online.unisc.br/seer/index.php/epidemiologia/article/view/18231*

by a Research Ethics Committee (REC)", even those that use secondary data, through the CEP-CONEP System. However, if the research uses only public domain data without identifying the participants or if it is a bibliographic review without the involvement of human beings, it does not need to be approved by REC-CONEP. Therefore, as this study uses public domain data, it was not necessary to submit it for REC assessment.

RESULTS

In literature, a total of 300 articles were found in the searched databases, of which 157 articles were excluded after selection, as they were duplicates, based on the detection of Rayyan®.[16] After exclusion, 149 articles remained for analysis. After reading titles, abstracts and reading in full, only 9 eligible articles were identified (Figure 1).

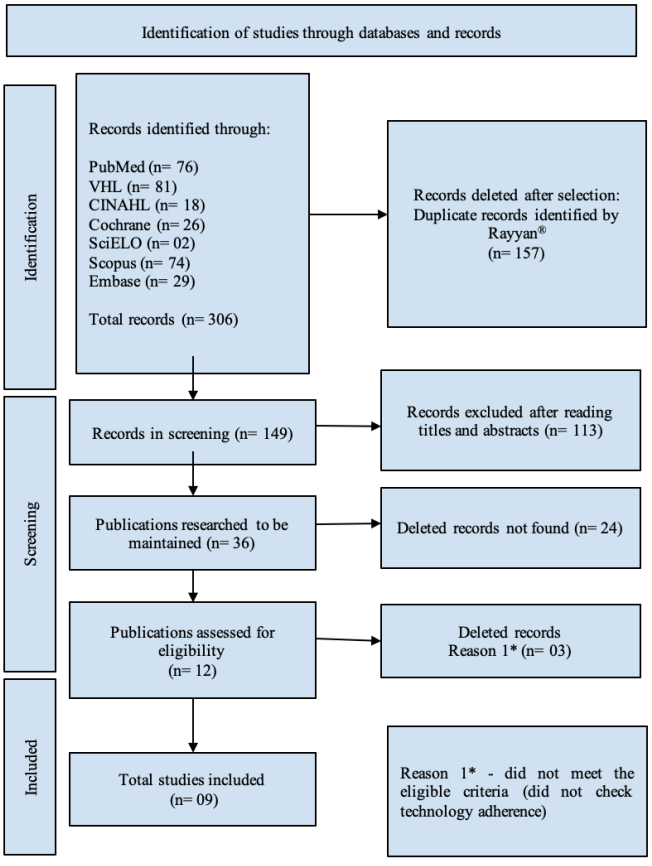

Figure 1. PRISMA 2020[12] flow diagram for new systematic reviews that included only database and record searches.

As shown in Chart 2, of the studies included, three[18-20] studies (33.3%) were carried out is America (North and South America), five,[21-25] (55.5%) in Asia, and one,[26] (11.1%) in Africa. The countries where the studies were carried out were: one[17] (11.1%) in Peru; two[21.24] (22.2%) in China; one[22] (11.1%) in Saudi Arabia; two[19-20] (22.2%) in the United States of America; one[26] (11.1%) in Ethiopia; and two[23-25] (22.2%) in India. Regarding design, five[20-22, 25.26] studies (55.5%) were defined as clinical trials; two[23-24] studies (22.2%) were quasi-experimental clinical trials; one[18] studies (11.1%) were descriptive; and one[19] study (11.1%) was a prospective cohort. The publication period of each study covered 2020 to 2022, with two[24-25] studies (22.2%) published in 2020, four[20.22-23.26] studies (44.4%) published in 2021 and three[18-19.21] studies (33.3%) published in 2021.

Six[19-23.26] studies (66.6%) used text messages (applications) and SMS as strategies; and three[19-21] studies (33.3%) presented the name of the technological application used in the study, namely WeChat® and Emocha Mobile Health®. Six[18-21,24,25] studies (66.6%) used videos ranging between synchronous and asynchronous; two[22.26] studies (22.2%) used only SMS; and one[23] studies (11.1%) used voice calls. The majority[20-26] of study participants were men (77.7%) aged 18 or over (77.7%).

The sample size of studies[18,25] varied between 10 and 405 participants with a confirmed diagnosis of TB. Samples were collected differently across studies, with participants divided into control and intervention groups. However, there were also studies in which participants, as in previous studies, were divided into two groups, control and intervention, with the difference that the sample of participants in the control group was collected from retrospective data. In both situations, the intervention concerned the use of digital health. Video and SMS technologies gained prominence in studies, being the most used strategies both together and separately.

Among the studies, the samples were diverse, as were the approaches and sample characteristics. Participants were found who received TB treatment for the first time or who had previously received treatment (retreatments). People with TB were classified as having pulmonary TB, extrapulmonary TB, or both.

Regarding objectives, five[18-20,23,26] studies (55.5%) verified adherence to treatment by controlling missed doses; three[22,24,25] studies (33.3%) analyzed adherence to treatment through completion of drug treatment (cure); and one[20] article (11.1%) demonstrated that, even with a higher percentage of doses not ingested in the technological intervention, there was an increase in treatment completion rates.

The studies had similar objectives related to the following categories: assess and compare adherence to treatment using digital health compared to conventional treatment in people diagnosed with TB; describe the characteristics of VDOT implementation; and assess the cost-benefit of applying technology in the treatment of people with TB.

The quality and evidence of studies were assessed using MMAT[17], as described in Table 1. Among the randomized controlled studies, four[21,22,24-25] were suspected of high quality, except for one[26] study, which did not report blinding sample allocation. Among the non-randomized

Please cite this article as: *Tártaro A, dos Santos Silva RV, Soares Tenório de Araújo J, Vieira Ramos AC, Zamboni Berra T, Mathias Alves Y, do Socorro Nantua Evangelista M, Fuentealba-Torres MA, Arcêncio RA. Saúde digital para a adesão ao tratamento da pessoa com tuberculose: uma revisão sistemática. Rev Epidemiol Control Infect [Internet]. 7º de novembro de 2023 [citado 20º de novembro de 2023];13(3). Disponível em: https://online.unisc.br/seer/index.php/epidemiologia/article/view/18231*

Chart 2. Characteristics of studies included in the review according to author, year, country, study design, study objective, population and results (2020 – 2022).

Author	Year	Country	Study design	Study objective	Population	Results
Peinado[18]	2022	Peru	Descriptive quantitative	Describe the characteristics of implementing video treatment (VDOT) in people with TB.	10 participants diagnosed with pulmonary TB, 7 participants being women and aged between 24 and 39 years.	Using recorded video calls made with commercial software, 100% treatment adherence was achieved, measured by observed doses.
Bao[21]	2022	China	Controlled, randomized, triple-blind	Explore a baseline mHealth intervention in participants with TB to increase their self-care capacity.	112 participants diagnosed with pulmonary TB. Of the total participants, 59% in the intervention group and 53% in the control group. 57.1% were men, aged between 18 and 30 years old and only 6.3% were over 60 years old.	Using WeChat®/videos and text messages, adherence in the intervention group increased with daily medication reminders, and adherence in the control group decreased over time by discontinuing the medication.
Al-Sahafi[22]	2021	Saudi Arabia	Controlled, randomized, triple-blind	Compare the approach of people with TB with those undergoing DOTS and VDOT unit treatment.	221 participants. Study participants were 34 years old. The majority of participants were male (66.5%). Pulmonary TB was the majority of cases (80%), and were divided into 97 in the intervention group and 76 in the control group.	Using SMS, it was found that the group that used the technology showed greater adherence to treatment, since the relative risk of treatment success rate among the intervention group was 1.27 times greater than the control group.
Bachina[19]	2022	USA	Prospective cohort	Assess the use of VDOT compared to treatment adherence between VDOT and in-person DOTS, and understand the impact of COVID-19 on adherence to TB treatment and technology adoption.	46 participants, the majority diagnosed with pulmonary TB. The average age was 41 years, with the majority being women and not born in the USA. They received treatment during the post-COVID-19 period.	Using Emocha Mobile Health®/video and SMS, verified adherence (proportion of doses observed) was significantly higher when using VDOT (average of 81%,) compared to in-person DOT (average of 54.5%, SD 10.9; P = 0.001).
Perry[20]	2021	USA	Pragmatic quantitative	Estimate the proportion of doses prescribed with administration verified by VDOT vs. DOTS in person.	163 participants, most diagnosed with pulmonary TB. Of the total participants, 61% were men, aged 52 years old, with the majority not born in the US.	Using Emocha Mobile Health®/video and SMS, it was found that, despite the DOT showing fewer wasted doses than the use of VDOT, treatment completion was higher in the group that received the app intervention, 96% to 90%, DOT strategy.
Gashu[26]	2021	Ethiopia	Controlled, randomized, double-blind	Assess the effect of the telephone reminder system on adherence to TB treatment.	306 participants, the majority diagnosed with pulmonary TB. In the intervention group, it was 55.3%, and in the control group, 48.7%. All were men aged between 18 and 29 years old.	Using SMS (text messaging and graphics for illiterates), it was found that adherence to treatment was 79% in the intervention and 66.4% in the control groups.
Santra[23]	2021	India	Quasi-experimental	Assess the mHealth package on medication adherence of people with TB through DOTS.	220 participants, divided into intervention and control groups. Of the total, the majority were men and over 18 years old.	Using text messages and voice calls, it was found that the group that received daily intervention increased adherence to 96.4% at the end (post-intervention) (P = 0.004)
Guo, X[24]	2020	China	Quasi-experimental	Assess acceptance of VOT for TB management.	393 participants diagnosed with pulmonary TB. There were 158 participants in the retrospective DOTS group and 235 in the VOT group, in both the majority were men, between 25 and 44 years old.	Using our own APP (video), it was found that all people were cured without recurrences.
Guo, P[25]	2020	Índia	Controlled, randomized, prospective	Assess the clinical benefit and cost-effectiveness of video therapy (VDOT) compared to the DOTS service.	405 participants diagnosed with pulmonary TB for the first time. Of the total, 203 went to VDOT and 202 to DOTS. The age ranged between 18 and 89 years old, with the majority being men.	Using an asynchronous video app, treatment completion rates were 96.1% with VDOT and 94.6% with DOTS.

quantitative studies, two[23-24] studies were considered to be of high quality, while one[20] studies were considered to be of moderate quality. Two[20,24] studies have shown inconsistencies in sample selection (selection bias), inconsistencies in the measurements used (measurement bias) and confounding factors related to the sample conduct. The quantitative descriptive studies[18-19] were classified as suspect of moderate quality, due to weaknesses in sampling strategy that was not relevant to address the quantitative research question as well as the sample size that was not representative of the population.

DISCUSSION

This study aimed to describe the use of digital health technologies to assist with adherence to TB treatment. It was observed that technologies, such as reminders via SMS, synchronous and asynchronous videos, and voice calls, are resources that can effectively contribute to TB treatment, increasing medication adherence rates and, consequently, improving disease cure rates.

In the systematic review, the technological strategies used in the interventions included automatic text messages to remind users of appointments and medication times as well as motivating phrases. Conversation channels were also used to answer questions about the side effects of medications, voice calls with healthcare professionals and asynchronous videos to observe medication taking. These strategies are aligned with what the literature demonstrates about the use of technologies.[28-29]

Table 1. Assessment of quality of evidence of included studies according to MMAT (2020-2022).

Design	Rating criteria				
Randomly controlled quantitative (trials)	**Randomization, sequence generation**	**Allocation concealment**	**Complete outcome data (80% or more)?**	**Low withdrawal/ dropout (below 20%)?**	**Comments**
Bao, 2022	****	****	****	****	High quality is suspected
Al-Sahafi, 2021	****	****	****	****	High quality is suspected
Gashu, 2021	****	****	****	****	High quality is suspected
Guo P, 2020	****	*	****	****	High quality is suspected
Non-randomized quantitative	**Minimum selection bias**	**Appropriate measures**	**Comparable study groups or differences represented by these groups**	**Outcome data 80% or greater, response rate 60% or greater, or acceptable rate of follow-up**	**Comments**
Santra, 2021	****	****	****	****	High quality is suspected
Guo X, 2020	**	**	***	****	High quality is suspected
Perry, 2021	*	*	*	***	Moderate quality is suspected
Quantitative descriptive	**Sampling strategy relevant to the research question**	**Representative sample of the population**	**Appropriate measures**	**Response rates equal to or greater than 60%**	**Comments**
Peinado, 2022	*	*	****	****	Moderate quality is suspected
Bachina, 2021	*	*	****	****	Moderate quality is suspected

Scores ranging from 25% (*)-one criteria met- to 100% (****)-all criteria met.

Medication self-management is a fear of many health professionals, who are resistant to adopting technologies within health services. However, the results of Perry's study[20] contradict these concerns, since, even with a higher incidence of missed doses using the combined SMS and video strategy, cure rates in the intervention group were better in relation to treatment completion. Likewise, the study by Bachina[19] showed different results, with greater medication adherence in the technological intervention group that used the same strategy. This indicates that the same technology can present different results depending on the context.

Technologies contain resources that can be considered a strategic approach to overcome nonadherence to TB treatment, which is one of the main predictors of resistant forms of the disease and treatment relapse. These factors make the process of healing and containing the disease difficult, damaging people's quality of life.[31] However, the use of technological resources has shown significant results in the persistence of drug treatment, with all articles demonstrating that adherence was equal or better than in the control group that used DOT, as in Bao's article,[21] in which the DOT group has a tendency to gradually stop monitoring until abandoning it completely.

Several factors can influence the decision-making of people with TB, such as socioeconomic factors, access to health services, social protection actions and lack of information or knowledge about the disease.[5] In this sense, technology can also be a resource to assist in the decision-making process of a person diagnosed with TB to adhere to treatment. It was observed that, whenever there was an option to choose between the approach with digital technology or traditional DOT, the preference was for the technological approach. Furthermore, an important factor in choosing VDOT was the optimization of time, avoiding waiting for care and/or transportation when traveling to the reference health unit to receive DOTS.

The technologies used in the studies were mainly synchronous VDOT, with only one study, which used asynchronous videos and SMS. VDOT has been shown

Please cite this article as: *Tártaro A, dos Santos Silva RV, Soares Tenório de Araújo J, Vieira Ramos AC, Zamboni Berra T, Mathias Alves Y, do Socorro Nantua Evangelista M, Fuentealba-Torres MA, Arcêncio RA. Saúde digital para a adesão ao tratamento da pessoa com tuberculose: uma revisão sistemática. Rev Epidemiol Control Infect [Internet]. 7º de novembro de 2023 [citado 20º de novembro de 2023];13(3). Disponível em: https://online.unisc.br/seer/index.php/epidemiologia/article/view/18231*

to be a viable approach to supporting TB medication adherence, even in situations where the Internet is not regularly available.This approach allows for person-centered care as well as safety, as it allows visualization of medication intake through recordings, allowing the professional to guide the correct form of administration, as recommended by DOT, but remotely.[28,29]

Although strategies that use only SMS do not demonstrate in the literature that they increase adherence compared to traditional treatment, it is a strategy that has important functions, such as scheduling appointments, remembering medication times and appointments already scheduled as well as signaling problems, if they arise, from adverse effects to delays.Another advantage is its simplicity, low cost and popularity, as it is available on all cell phones.[28,29]

In the study by Guo *et al*. (2020),[25] the strategy used was SMS, and graphics and images were sent in these messages, in order to also include illiterate people. Inclusion strategies are extremely important, given that TB is a disease that mostly affects people in socially vulnerable situations, and is associated with low education.[28,29]

Three[18,23,26] studies (33.3%) included in the review originate from countries considered emerging and developing, which demonstrates an interest on the part of low-income countries in implementing digital health as a strategy to overcome access barriers to health services, improving quality of care provision and advancing improvements in health indicators, as recommended by the End TB Strategy.[1,28]

It should be noted that, among the studies found in the literature review, developed countries, such as the United States of America and China, also demonstrated that they seek to understand the adoption of digital technology in TB treatment, thus aiming to better serve the population with TB.[1,29]

Some studies[24,25] have shown that the use of digital technologies significantly reduced transportation costs for users, since in these countries the health service does not offer free transportation or tickets.[30] In a scenario of global economic crisis, further aggravated by the COVID-19 pandemic, where social inequalities have become even more exacerbated, the use of digital resources to monitor cases becomes essential. Therefore, the use of digital technologies for the sustainability of DOT is considered a valid, safe and effective strategy, bringing several benefits to both users and the health service, highlighting cost reduction and time optimization for professionals and people with TB.[30]

It is noteworthy that only three studies described in detail which technologies were being applied, using Emocha Mobile Health®.[19,20] and WeChat®.[21] The technology used in each study was little discussed, which raises an important gap in knowledge, as better exploring available technologies and relying on examples and experience reports can help managers define strategies and devices to ensure quality of care and adherence to treatment.

The plurality of approaches that technology allows us to explore is wide, and studies show that, in general, technologies are a way of bringing users and health professionals closer together and considering people with TB, considering their autonomy, believing that they want to be treated. This involves working with mutual responsibility and making them the protagonist of their treatment.[1,2,28,29]

Despite the great potential for adherence to medications and achieving a cure outcome, scientific evidence is still limited, and there is a need for further investigations as well as more assertive criteria. Furthermore, it is important to define the names of the applications used and assess the cost of implementing the technology. It is also noteworthy that the grouping of heterogeneous studies did not allow for a qualitative synthesis.

Digital health is not intended to replace conventional treatment, and it is crucial that the strategy used in treatment is centered on people with TB, respecting their needs and, above all, their preferences. The use of digital health among people diagnosed with TB can be a great complementary strategy to health services, with the aim of increasing adherence to treatment and impacting the disease's epidemiological data in the country.[28-29]

CONCLUSION

The use of health technologies as well as conventional treatment appears to be complementary and fundamental for TB control, based on the evidence found in the study countries. It is important to give greater visibility and encouragement to social issues related to understanding the particularities of each person living with the disease, aiming to contemplate and complete treatment.

The systematic review highlighted the relevance of using digital health for TB treatment and its contribution to improving adherence. These results are aligned with the Sustainable Development Goals of the 2030 agenda, especially goal 3.3, which seeks to promote person-centered care rather than just controlling them.

Digital health involves strengthening the bond, the use of an intercultural language, co-responsibility and individuals' leading role in their health-disease process. Digital health does not consist of robotization and mechanization of care, but rather the complementation of the essential basis of care, which is based on human relationships.

FUNDING

Tártaro AF received funding from the Coordination for the Improvement of Higher Education Personnel (CAPES - *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*), Financing Code 001. Arcêncio RA received funding from the National Council for Scientific and Technological Development (CNPq - *Conselho Nacional de Desenvolvimento Científico e Tecnológico*), Process 405902/2021-2.

REFERENCES

1. The End TB Strategy. World Health Organization. 2022. https://www.who.int/teams/global-tuberculosis-programme/the-end-tb-strategy
2. Brasil livre da tuberculose - Plano nacional pelo fim da tuberculose como problema de saúde pública: estratégias para 2021-2025. Ministério da Saúde. 2021 https://www.gov.br/saude/ptbr/centraisdeconteudo/publicacoes/publicacoessvs/tuberculose/plano-nacional-pelo-fim-da-tuberculose-como-problema-de-saudepublica_-estrategias-para-2021-2925.pdf/view
3. World Health Organization. Global Tuberculosis Report 2020. https://www.who.int/publications/i/item/9789240013131
4. Brasil. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Manual de Recomendações para o Controle da Tuberculose no Brasil – Brasília: Ministério da Saúde, 2019. https://www.gov.br/saude/pt-br/centrais-deconteudo/publicacoes/svsa/tuberculose/manual-de-recomendacoes-e-controle-da-ttuberculose-no-brasil-2a-ed.pdf/view
5. Fernandes TS, Pedrosa NS, Garcia MKQ, et al. Estigma e preconceito na atualidade: vivência dos portadores de tuberculose em oficinas de terapia ocupacional. Physis 2020;30(1):e300103. doi: 10.1590/S0103-73312020300103
6. McQuaid CF, McCreesh N, Read JM, et al. The potential impact of COVID-19-related disruption on tuberculosis burden. Eur Respir J. 2020;56(2):2001718. doi: 10.36416/1806-3756/e20210044
7. Rossato SD, Carvalho de QMF, D'Ambrosio, et. al. Tuberculosis and COVID-19, the new cursed duet: what differs between Brazil and Europe? J Bras Pneumol. 2021. doi: 10.36416/1806-3756/e20210044
8. Berra TZ, Bruce ATI, Alves YM, et al. Fatores relacionados, tendência temporal e associação espacial do abandono de tratamento para tuberculose em Ribeirão Preto-SP. Revista Eletrônica de Enfermagem. 2020. doi: 10.5216/ree.v22.58883
9. Brasil. Ministério da Saúde. (BR). Brasil Livre da Tuberculose: Plano Nacional pelo Fim da Tuberculose como Problema de Saúde Pública. Brazil Free from Tuberculosis: National Plan to End TB as a Public Health Problem. 2017;(1a edição):54. https://bvsms.saude.gov.br/bvs/publicacoes/brasil_livre_tuberculose_plano_nacional.pdf
10. Maldonado JMS de V, Marques AB, Cruz A. Telemedicine: challenges to dissemination in Brazil. Cad Saúde Pública. 2016. doi: 10.1590/0102-311X00155615
11. Silva CRDV, Lopes RH, Jr O de GB, Martiniano CS, Fuentealba-Torres M, Arcêncio RA, et al. Digital Health Opportunities to Improve Primary Health Care in the Context of COVID-19: Scoping Review. JMIR Human Factors. 2022. doi: 10.2196/35380
12. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021. doi: 10.1136/bmj.n71
13. Garritty C, Gartlehner G, Kamel C, King VJ, Nussbaumer-Streit B, Stevens A, Hamel C, Affengruber L. Cochrane Rapid Reviews. Interim Guidance from the Cochrane Rapid Reviews Methods Group. March 2020.
14. World Health Organization. Adherence To Long Term Therapies: Evidence For Action. World Health Organization. Geneva: World Health Organization, 2003. https://apps.who.int/iris/handle/10665/42682
15. Santos CM da C, Pimenta CA de M, Nobre MRC. The PICO strategy for the research question construction and evidence search. Rev Latino-Am Enfermagem. 2007. doi: 10.1590/S0104-11692007000300023
16. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Systematic Reviews. 2016. doi: 10.1186/s13643-016-0384-4
17. Hong QN, Fàbregues S, Bartlett G, et al. The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. Education for Information. 2018:285–291. doi: 10.3233/EFI-180221
18. Peinado J, Tamaki J, Yataco R, Pages G, et al. Tratamiento supervisado por video VDOT en pacientes con tuberculosis pulmonar de un Centro de Salud de Lima. Estudio piloto. Revista Medica Herediana. 2022. doi: 10.20453/rmh.v33i1.4163
19. Bachina P, Lippincott CK, Perry A, et al. Programmatic Adoption and Implementation of Video-Observed Therapy in Minnesota: Prospective Observational Cohort Study. JMIR Form Res. 2022;6(8):e38247. doi: 10.2196/38247
20. Perry A, Chitnis A, Chin A, Hoffmann C, et al. Real-world implementation of video-observed therapy in an urban TB program in the United States. Int J Tuberc Lung Dis. 2021;25(8):655–61. doi: 10.5588/ijtld.21.0170
21. Bao Y, Wang C, Xu H, et al. Effects of an mHealth Intervention for Pulmonary Tuberculosis Self-management Based on the Integrated Theory of Health Behavior Change: Randomized Controlled Trial. JMIR Public Health Surveill. 2022;8(7):e34277. doi: 10.2196/34277
22. Al-Sahafi A, Al-Sayali MM, Mandoura N, et al. Treatment outcomes among tuberculosis patients in Jeddah, Saudi Arabia: Results of a community mobile outreach directly observed Treatment, Short-course (DOTS) project, compared to a standard facility-based DOTS: A randomized controlled trial. J Clin Tuberc Other Mycobact Dis. 2020;22:100210. doi: 10.1016/j.jctube
23. Santra S, Garg S, Basu S, et al. The effect of a mhealth intervention on anti-tuberculosis medication adherence in Delhi, India: A quasi-experimental study. Indian Journal of Public Health. 2021;65(1):34. doi: 10.4103/ijph.IJPH_879_20
24. Guo X, Yang Y, Takiff HE, et al. A Comprehensive App That Improves Tuberculosis Treatment Management Through Video-Observed Therapy: Usability Study. JMIR Mhealth Uhealth. 2020;8(7):e17658. doi: 10.2196/17658
25. Guo P, Qiao W, Sun Y, Liu F, Wang C. Telemedicine Technologies and Tuberculosis Management: A Randomized Controlled Trial. Telemedicine and e-Health. 2020; 26(9):1150–6. doi: 10.1089/tmj.2019.0190
26. Gashu KD, Gelaye KA, Lester R, et al. Effect of a phone reminder system on patient-centered tuberculosis treatment adherence among adults in Northwest Ethiopia: a randomised controlled trial. BMJ Health Care Inform. 2021;28(1):e100268. doi: 10.1136/bmjhci

27. Almeida CPB de, Goulart BNG de. How to avoid bias in systematic reviews of observational studies. Rev CEFAC. 2017;19(4):551–5. doi: 10.1590/1982-021620171941117

28. World Health Organization. Who a Patient-Centred Approach to TB Care. Geneva: World Health Organization, 2018. https://apps.who.int/iris/bitstream/handle/10665/272467/WHO-CDS-TB-2018.13-eng.pdf?ua=1

29. World Health Organization. Handbook for the use of digital technologies to support tuberculosis medication adherence. World Health Organization. 2017. https://apps.who.int/iris/handle/10665/259832

30. Banco de dados do World Economic Outlook abril de 2022 - Grupos e informações agregadas do WEO. 2022. https://www.imf.org/external/pubs/ft/weo/2022/01/weodata/groups.htm

31. ODS 3 - Saúde e Bem-estar - Ipea - Objetivos do Desenvolvimento Sustentável. Meta número 3.3. 2019. https://www.ipea.gov.br/ods/ods3

AUTHORS' CONTRIBUTIONS

Ariela Fehr Tártaro and **Ricardo Alexandre Arcêncio** contributed to study conception and design, analysis and interpretation of results, manuscript content writing and critical review.

Ruan Victor dos Santos Silva and **Juliana Soares Tenório de Araújo** contributed to data analysis and interpretation, manuscript content writing and critical review.

Antônio Carlos Vieira Ramos, **Thaís Zamboni Berra**, **Yan Mathias Alves**, **Maria do Socorro Nantua Evangelista** and **Miguel Angel Fuentealba-Torres** contributed to study conception and design, manuscript content writing and critical review. All authors approved the final version to be published and are responsible for all aspects of this work, including ensuring its accuracy and integrity.