REVIEW ARTICLE

Digital Health Adherence Technology for Pulmonary TB Management: A Narrative Review

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Abstract

A significant worldwide health burden, millions of new cases of tuberculosis (TB) are recorded each year. Ensuring patient adherence to therapy, which is essential for positive results and limiting the emergence of drug resistance, is one of the main problems in the management of tuberculosis. Electronic pillboxes, video directly observed therapy (VDOT), and mobile health (mHealth) applications are a few examples of digital health adherence technologies that show promise in improving TB treatment adherence. Utilising digital health adherence technology to manage tuberculosis is also a promising approach. Due to its high rates of morbidity and mortality, tuberculosis (TB) continues to be a serious public health concern in Pakistan. Digital health interventions provide innovative approaches to enhance tuberculosis management and control. This study examines the state of digital health initiatives for managing tuberculosis in Pakistan, evaluates their effectiveness, and identifies potential obstacles to their implementation.

Keywords: *Tuberculosis, digital health, adherence technologies, pulmonary TB, video directly observed (VDOT), mobile health (mHEALTH), electronic pillboxes, treatment compliance, telemedicine, TB management.*

INTRODUCTION

Tuberculosis or TB, the disease, remains a concern for public health in Pakistan and worldwide. The World Health Organisation states that tuberculosis (TB) continues to be the leading cause of death in nations with lower-middle incomes like Pakistan and is among the top 10 causes of death globally. Due to multiple new cases reported annually, Pakistan has a significantly greater TB burden [1]. Standard six-month therapy for drug-susceptible TB provides improved treatment adherence and patient outcomes related to tuberculosis. Studies have shown that digital remedies, such as digital pill boxes and video-observed treatments, help enhance adherence and reduce expenses when widely used [2]. As emphasised by research, digital adherence technologies are essential in promoting tuberculosis treatment adherence, with data showing that DATs can decrease undesirable treatment outcomes compared to regular therapy.

Additionally, the costs, efficiency, and equity impacts of displaying DATs in Ethiopia are being evaluated by the ASCENT-Ethiopia research to provide a financial rationale for the global adoption of these technologies [3]. With everything in mind, by improving availability, effectiveness, and patient-centeredness, TB patient clinical trials can be entirely transformed by digital health technologies. This treatment plan is highly effective in curing diseases and reducing the risk of transmission [4].

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To successfully fight this global health issue, these hurdles must be addressed, along with better access to high-quality healthcare services, spreading awareness of the importance of adhering to TB treatment, and increasing efforts to stop the spread of the disease through early diagnosis, timely beginning of therapy, and proper adherence to the recommended regimen. The adherence to anti-TB medications is sometimes time-bound and complex. The effectiveness of treatment depends on patient adherence to anti-TB medicine. According to the World Health Organisation, successful outcomes in tuberculosis therapy require careful consideration when providing patient-centred care [5]. The principal goal is to end tuberculosis. This needs an all-inclusive approach that comprises social, biological, public health, and economic interventions. As such, it is essential to provide integrated, patient-centred care and prevention as a top priority. Three pillars comprise a comprehensive intervention package necessary to achieve this goal. The first pillar focused on integrated, patent-centric care and prevention, which calls for expanding and improving the main TB program components, such as using contemporary technology to enhance patient care [6].

Treatment adherence and outcome were severely hampered by the DOT's (directly observed therapy) adoption. After a thorough examination of the literature, no solid, conclusive proof of DOT's ability to enhance treatment results and adherence was discovered. Therefore, implementing a patient-centric approach could be a prudent way to reallocate resources to improve treatment outcomes and adherence. Increased

accessibility to communication technologies and the internet worldwide presents a significant opportunity to address several TB management challenges [7]. The purpose of this article is to provide a latest knowledge on the evidence regarding the definition of non-adherence to anti-TB medication, factors that contribute to medication non-adherence, the effectiveness of DOT and its alternatives, and the use of digital interventions such as electronic health records (EHRs), telemedicine, video assisted treatment, and mobile health (mHealth), which now have created new approach for TB control and prevention of multidrug resistant TB cases [8].

Firstly, Mobile Health (mHealth) applications can offer ways of communication with healthcare practitioners, educational materials, and medication adherence reminders [9]. These applications also collect data on the progress of treatment medications and compliance with medication, which is helpful for monitoring and evaluating results. Secondly, Electronic pillboxes are gadgets that can be set to deliver medicine at specific times and remind users when to take their medication [10]. These digital applications can also document compliance data, which health care providers can access at any time to monitor adherence to prescribed treatments [11]. Lastly, Video Directly Observed Therapy (VDOT) instructs patients to record and email videos of themselves by taking prescribed medication to health care professionals [12]. Compared to traditional directly observed therapy (DOT), this approach will be more convenient for patients residing in remote areas and having limited or no access to healthcare facilities.

Advantages of Adherence to Digital Health Technology Treatment

- Improves treatment compliance and adherence rates.
- A reduction in in-person outpatient visits in hospitals was crucial during the COVID-19 pandemic.
- Helpful in tracking the effectiveness of treatment in real time.
- Uses interactive features to improve patient education and engagement.

Challenges and Considerations

- Certain areas have restricted access to digital technologies.
- Security and privacy issues with patient data.
- The viability and affordability of putting digital health solutions into practice.
- The necessity of educating patients and healthcare professionals about these technologies

Future Directions: Treating and controlling tuberculosis could be significantly improved by incorporating digital health adherence technologies into existing tuberculosis management programs.

Future studies should concentrate on:

- Assessing these technologies' cost-effectiveness in various contexts.
- Creating standards and best practices for the application of digital health technology in tuberculosis control.
- Addressing obstacles to access, such as connectivity and infrastructure issues, particularly in environments with limited resources.

METHODOLOGY

To identify and assess the most recent studies and literature on digital health applications for tuberculosis management, a narrative review approach was employed in the current study. The narrative review was conducted using the following procedures: To identify pertinent publications, research, and reviews on digital health applications for tuberculosis management, a comprehensive literature search was conducted. To search relevant databases and articles that were published between 2015 and 2023, a net search was conducted, using PubMed, Google Scholar, Research Gate, and others, along with keywords like digital health (DAT), mobile health, telemedicine, video-assisted treatment (VAT), electronic health record (EHR), and SMS reminder.

Inclusion criteria used to choose studies for this review: 1) The study concentrated on digital health tools, particularly those for tuberculosis treatment, 2) The studies that focused on evaluations of the influence and efficacy of digital health apps for tuberculosis management were included in the study, and 3) The studies were published in English.

The exclusion criteria listed below were implemented:

1. Digital health applications for tuberculosis management were not the focus of the study.
2. There was no English publication for the study.
3. Evaluations and assessments of the influence or efficacy of digital health apps for tuberculosis management were absent from the study.
4. Duplicate papers were eliminated following the initial literature search, and the remaining articles were examined using their titles and abstracts to find relevant data and information. The remaining papers were then thoroughly reviewed.

FINDINGS AND DISCUSSION

Digital health technologies offer the potential to enhance treatment compliance and improve patient outcomes related to TB; however, their implementation is hindered by several issues, including the need for substantial funding, a reliable and uninterrupted internet connection, and the fact that not all patients have access to digital health centres.

In recent times, digital health technologies have shown potential for helping patients with pulmonary tuberculosis adhere to their treatment regimens by providing real-time support and supervision [13]. Usually, it was done by performing standard procedures, such as home visits or phone calls from medical professionals, family members, or volunteers; however, these methods can be resource- and time-intensive. Therefore, the proper use of digital technologies such as messaging apps like WhatsApp and others available with smartphones, which inform in a timely with alerts and reminders to take the medication on time and at the same time continuously monitor and record treatment adherence so the healthcare professional can immediately acknowledge and solve any issues regarding non-adherence, it is a more feasible and budget friendly way. To gain a clearer insight into patients' conditions and the importance of adhering to their medication schedule, social monitoring support and educational pamphlets in their local languages are also provided [14]. According to a study in China, these digital health interventions have shown improvement in TB care by monitoring patients' adherence to treatment digitally, which is encouraging [15]. Researchers in the future should focus on conducting more comprehensive studies, such as non-inferiority studies and affordability evaluations, to assess the sustainability and long-term effects of these digital health treatments and study how they can be combined [16].

Additionally, the latest techniques and innovations that have not been tried and tested yet could also be investigated. While there is no doubt about the capabilities of these modern tools, it is crucial to consider any possible drawbacks and limitations. The likelihood that some patients may not be able to use digital health adherence technology, especially those in remote or low-resource areas, is one of the leading causes of worry, as not all patients have access to secure internet connections or mobile phones, which leads to decreased efficiency and reach of digital monitoring and reminders [17].

Furthermore, there's a risk of undermining personalised human interaction in the healthcare environment due to over-dependence on digital technology. Aside from their benefits, digital alerts and reminders may not be able to overcome the psychological and social barriers that prevent patients from taking their medication on time. For instance, some individuals may require more extensive support beyond digital therapies, suggesting that combining digital health treatments with conventional forms of assistance could be necessary [18].

CONCLUSION

In conclusion, the implementation of digital health technologies must be approached with a critical understanding of their limitations and potential drawbacks. Future research should prioritise evaluating integrated strategies that combine digital health interventions with traditional care models. This includes addressing infrastructural and socioeconomic barriers to improve access in remote and underserved areas, while also assessing the long-term sustainability and impact of these interventions. To ensure equity and effectiveness, digital health solutions should be designed to support, not replace, conventional treatment methods for pulmonary tuberculosis. Their primary aim should be to enhance patient adherence and improve treatment outcomes. Additionally, targeted efforts are needed to bridge the digital divide and ensure that marginalised populations have equitable access to these technologies. By focusing on inclusive, sustainable, and evidence-based approaches, digital health initiatives can significantly strengthen treatment adherence for pulmonary tuberculosis, reduce default rates, and alleviate the burden of multidrug-resistant TB on Pakistan's healthcare system.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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AUTHOR'S CONTRIBUTION

Huma Ahsan and Fatima Qazi contributed equally to the conception, literature search, writing, and critical revision of the manuscript. Both authors reviewed and approved the final version of the article and agree to be accountable for all aspects of the work.

GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work the authors limitedly used ChatGPT to get language suggestions and do minor proofreading in some parts of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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