Patient–Centered Digital Interventions for Self–Care Ability Among People with Pulmonary Tuberculosis: A Systematic Review

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Abstract: Tuberculosis remains a significant global health issue, with adherence to treatment essential for positive outcomes. This systematic review evaluated the effectiveness of patient-centered digital interventions (e.g., mobile health apps, SMS reminders, video-observed therapy) in promoting self-care behaviors among people with pulmonary tuberculosis and identified implementation challenges. A review of studies published between 2019 and 2024 was conducted across six databases, guided by the PRISMA framework. Eligible studies included adults with pulmonary tuberculosis, utilized digital interventions and reported outcomes on treatment adherence, completion rates, patient knowledge, quality of life, cost-effectiveness, and satisfaction. The study designs consisted of randomized controlled trials, quasi-experimental studies, and observational studies with control groups. Data were synthesized narratively due to heterogeneity in interventions and outcomes.

Twenty studies from 12 countries, involving over 9,000 participants, were included. Digital interventions showed significant improvements in treatment adherence in six out of ten studies, but evidence for improved completion rates was less conclusive. Patients generally found digital interventions acceptable and satisfactory. Implementation challenges included technological barriers, connectivity issues, and privacy concerns. Facilitators included user-friendly design, contextual customization, and adequate support. Patient-centered digital interventions promise to enhance treatment adherence for pulmonary tuberculosis but have fewer clear effects on completion rates. Future research should address identified challenges and explore long-term impacts on patient knowledge and quality of life.

Keywords: Medication adherence, Patient-centered care, Self-care, Systematic review, Telemedicine, Tuberculosis, Pulmonary

Received 3 August 2024; Revised 12 September 2024; Accepted 13 September 2024

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https://doi.org/10.60099/prijnr.2025.270467

Introduction

Tuberculosis (TB) continues to pose a significant global health challenge, especially in low- and middle-income nations. In 2019, approximately 10 million individuals were diagnosed with TB worldwide, establishing it as one of the top causes of mortality globally.[1] Pulmonary TB, the most common form, is preventable and curable but continues to impose substantial health and economic burdens.[2] Effective self-care, especially medication adherence, is crucial for successful TB treatment and preventing drug resistance.[3] However, the lengthy treatment and side effects often lead to poor adherence and treatment discontinuation.[4] Traditional support methods like directly observed therapy (DOT) are effective but resource-intensive and may not always align with patient preferences.[5]

Digital health interventions, including mobile health (mHealth) applications, short message service (SMS) reminders, and telemedicine, show promise in supporting self-care and improving treatment adherence in TB management.[6] The success of these interventions depends on the specific technology used and the target population's characteristics. For instance, smartphone-based video observed therapy (VOT) improved treatment adherence in urban settings, while text message reminders were more effective in rural areas with limited smartphone access.[7] There is a need to explore these interventions across diverse socioeconomic contexts, considering factors like technology access, literacy, and cultural attitudes toward digital health.[7] From a nursing perspective, these interventions could significantly impact patient care and the role of nurses in TB management. However, there are gaps in understanding the full range of digital interventions for TB self-care, their effectiveness across contexts, and their implications for nursing practice.

While digital interventions show promise in improving TB care, particularly in treatment adherence and patient engagement, significant gaps persist. The evidence on patient-centered digital interventions for pulmonary TB across various socioeconomic contexts is incomplete, and their implications for nursing practice are underexplored. Additionally, how these interventions integrate with existing TB care models, such as the Chronic Care Model, is not well understood. These interventions' long-term effects and cost-effectiveness, particularly in resource-constrained environments, remain uncertain. This review aims to fill these knowledge gaps by compiling evidence on their effectiveness, implementation challenges, and nursing implications.

Literature Review

The standard care for tuberculosis (TB) has evolved significantly over the years, with the World Health Organization (WHO) advocating a patient-centered approach to treatment. This strategy emphasizes the importance of daily drug regimens and fixed-dose combination tablets to improve adherence, alongside the established Directly Observed Treatment, Short-course (DOTS) model. DOTS, particularly when integrated with patient education and counseling, has demonstrated improved treatment outcomes.[3] Moreover, the introduction of new drugs such as bedaquiline and delamanid offer hope in treating multidrug-resistant TB (MDR-TB).[8]

Improving adherence to TB treatment remains a multifaceted challenge. Evidence suggests that combining interventions like case management with DOTS is more effective than DOTS alone.[9] Personalized interventions, including community-supervised DOTS and SMS reminders, have shown varying degrees of effectiveness.[10] However, the efficacy of SMS reminders, particularly in improving adherence, still requires further exploration.[11]

The journey of TB care is fraught with numerous challenges. Patients often struggle with treatment fatigue, socioeconomic barriers, stigma, and comorbidities, which complicate their treatment adherence.[12] In low-resource settings, additional challenges such as drug stock-outs

and a shortage of trained healthcare workers further exacerbate these issues.[13] Nurses, especially those in resource-limited environments, face immense pressure due to high workloads and the necessity for ongoing training to stay abreast of evolving treatment protocols.[14]

Self-care approaches have emerged as a critical component in TB management. These approaches, which encourage patients to take an active role in their health, have been shown to enhance treatment adherence and improve quality of life.[15] Patient-centered care models, including self-administered treatment, have proven to be as effective as DOTS in certain contexts, offering a viable alternative for specific patient populations.[16]

Digital health interventions are gaining traction in TB care, demonstrating significant potential to enhance treatment outcomes. For example, low-cost SMS interventions have markedly improved TB treatment completion rates.[17] Video observed therapy (VOT), another digital innovation, has been identified as more cost-effective than in-person DOT in the UK.[18] However, the broader application of digital technologies in high-burden TB settings requires more robust evidence.[19] The scaling up of digital interventions presents challenges, including concerns over data privacy and health equity.[20]

Integrating the Chronic Care Model (CCM) into TB care demonstrated potential benefits. The CCM, which focuses on components like health system organization, decision-making support, clinical information systems, self-management assistance, and community resources, has proven effective in the management of chronic diseases within primary care environments.[21] Aligning TB care with CCM principles has led to improved outcomes,[22] and digital interventions can further enhance these components, particularly in supporting self-management and system responsiveness.[23]

From a nursing perspective, the role of nurses in TB care, particularly in resource-constrained settings, is indispensable. Nurses often spearhead integrated TB-HIV care models, and the advent of digital health tools has the potential to improve patient monitoring and care delivery.[24] However, these tools can also increase workloads, requiring careful consideration in their implementation.[25] Mobile health applications, in particular, have shown promise in supporting more efficient and personalized TB care, especially within community settings.[26]

Aim

This review aimed to synthesize evidence on patient-centered digital interventions for self-care in pulmonary TB, focusing on their effectiveness, implementation challenges, and implications for nursing practice. We hypothesized that these interventions would enhance treatment adherence and completion rates compared to standard care, though effectiveness may vary by socioeconomic context.

Methods

Protocol and Registration: This systematic review protocol is registered with PROSPERO under number CRD42024563077 and conducted according to Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines.

Eligibility Criteria: We included studies based on the following criteria: adults (≥ 18 years) with pulmonary tuberculosis diagnosed in any setting (outpatient, inpatient, community). The interventions were patient-centered digital tools aimed at promoting self-care behaviors, such as mHealth apps, SMS reminders, telemedicine, and wearables. Comparators included standard care, non-digital interventions, or no intervention. Primary outcomes were treatment adherence and completion rates, while secondary outcomes included

patient knowledge, quality of life, cost-effectiveness, patient satisfaction, and implementation challenges. We considered RCTs, cluster-RCTs, quasi-experimental studies, and observational studies with control groups, excluding case reports, case series, and studies without a control group. These inclusion criteria were consistently applied throughout the study selection process, with reasons for exclusion meticulously documented during the full-text screening phase.

Information Sources: A comprehensive search was conducted across electronic databases from 2019 to August 2024, including PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science, ProQuest, ScienceDirect, and Scopus, focusing on studies published in English.

Search Strategy: The search strategy used a mix of Medical Subject Headings (MeSH) and free-text terms related to tuberculosis, digital interventions, and self-care. A sample search strategy for PubMed is presented in the **Appendix, Table 1**, with modifications for other databases. The search strategy was limited to electronic database searches. No grey literature or hand searches were conducted, which may have affected the comprehensiveness of the review. Publication bias was assessed by examining the likelihood of publication bias across included studies and considering its potential impact on the review findings.

Study Selection: Three reviewers independently screened titles and abstracts for eligibility. Full texts of potentially eligible studies were reviewed by the same two reviewers, with disputes resolved through discussion or consultation with additional reviewers. Screening and documentation were managed with Mendeley software.

Data Extraction: Data were extracted using a standardized form by two independent reviewers, with discrepancies resolved through discussion or arbitration. Extracted information included Study and Participant Characteristics, Intervention Details, Outcome, Results, and Implementation challenges and facilitators.

Risk of Bias Assessment: Two reviewers independently assessed the risk of bias for each study using the Risk of Bias 2 (RoB 2) for randomized controlled trials and Risk Of Bias In Non-randomised Studies - of Interventions (ROBINS-I) for non-randomized studies. Disagreements were resolved by additional reviewers. Publication bias was evaluated by examining the risk of bias and the potential impact of unpublished studies.

Data Synthesis: The findings from the studies were synthesized narratively, highlighting intervention types, target population characteristics, and outcome measures. We also summarized implementation challenges and facilitators identified in the studies. Due to the expected heterogeneity in interventions and outcome measures, we did not conduct meta-analyses.

Certainty of Evidence: We utilized the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) system to evaluate the level of confidence in the evidence for each outcome.

Results

Study Selection

The search yielded 523 records from PubMed (44), Cochrane CENTRAL (19), Web of Science (7), ProQuest (29), ScienceDirect (348), and Scopus (76). After removing 45 duplicates, 478 records remained. Of these, 293 were excluded for irrelevant titles and 149 for irrelevant abstracts. Thirty-six reports were sought for retrieval, with five unobtainable. The remaining 31 reports were assessed, leading to the exclusion of 11 due to incorrect study design (5), population (2), or intervention (4). Consequently, 20 studies were included in the review **(Figure 1).**

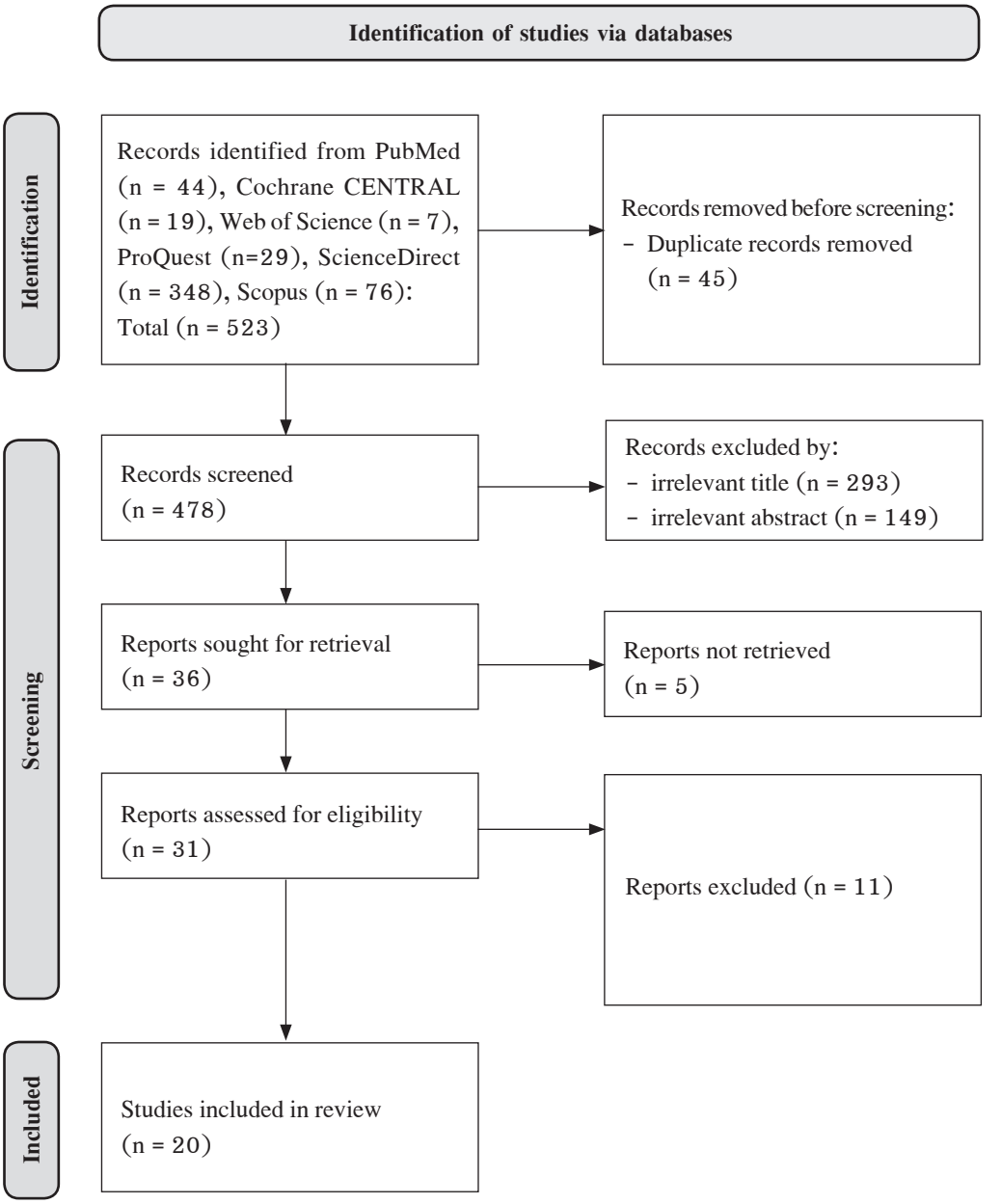

Figure 1. Flow diagram selection process

Study Characteristics

This systematic review included 20 studies published between 2019 and 2024, evaluating digital interventions for tuberculosis (TB) treatment adherence. The studies were conducted across 12 countries, with nine studies from low- and middle-income countries and three from high-income countries. In low- and middle-income countries, the research was conducted in Uganda,[27-30] South Africa,[31] Ethiopia,[32] China,[33,34] Thailand,[35] Argentina,[36] India,[37-40] Tibet,[41] and Morocco.[42] In high-income countries, the studies were conducted in the USA[43-45] and the UK.[18]

Eight studies employed randomized controlled trial designs,[18,31–33,35,36,41,43] while others used quasi-experimental,[39] observational,[38,42,44,46] and mixed-methods approaches.[27,28] Additional study designs included a feasibility study,[40] a comparison study,[47] a pre-post study,[38] a usability study,[46] and economic evaluations.[29,45] Sample sizes ranged from 25 to 3,074 participants, with a total of at least 9,254 participants across all studies.

The digital interventions evaluated included mobile applications (n = 5),[27,30,36,44,46] SMS reminders (n = 4),[27,28,31,39] video-observed therapy (VOT) (n = 6),[18,35,40,43,45,46] electronic monitors/99DOTS (n = 5),[29,32,38,47,48] and other digital adherence technologies (n = 3).[28,41,42] Intervention durations varied from 8 weeks to 78 weeks, with most studies focusing on the intensive phase of TB treatment. **Appendix Table A2** presents the key characteristics of the included studies.

Quality Assessment of Included Studies

The quality of the included studies was evaluated using the Cochrane Risk of Bias tool for randomized controlled trials (RCTs) and the ROBINS-I tool for studies that were not randomized. Of the eight RCTs, five had a low risk of bias, and three had some concerns. Among the twelve non-randomized studies, four were rated low risk, six moderate risk, and two serious risks of bias. The primary issues were confounding and selection bias.

Effects of Interventions

Primary Outcomes:

Treatment Adherence: Ten studies reported on treatment adherence. Six studies found significant improvements in adherence with digital interventions compared to standard care, while four studies found no significant difference or mixed results. Studies showing significant improvements include Kumwichar et al.[35] who reported a mean difference of 15.2 days in compliance during the intensive phase (95% CI 4.8–25.6; p = .005) using smartphone-based video-observed therapy (VOT). Burzynski et al.[43] demonstrated that electronic DOT was non-inferior to in-person DOT, achieving high completion rates for doses administered. Manyazewal et al.[32] showed non-inferiority of mobile electronic medication adherence technology (MERM) to in-person DOT. Story et al.[18] found that video-observed therapy (VOT) was significantly more effective than DOT in achieving treatment outcomes, with higher adherence rates. Santra et al.[39] reported that mHealth intervention significantly improved medication adherence among people with pulmonary tuberculosis on DOTS therapy. Guo et al.[34] demonstrated significantly higher observed doses with VOT compared to routine DOT.

Studies showing no significant difference or mixed results include Liu et al.,[33] who found that digital adherence technologies did not significantly affect primary outcomes compared to standard care. Thomas et al.[37] reported that 99DOTS exhibited suboptimal accuracy in measuring adherence. Chen et al.[38] observed that despite widespread adoption, 99DOTS did not significantly improve TB treatment outcomes. Musiimenta et al.[27] found mixed results, with some people with pulmonary tuberculosis reporting improved adherence while others faced challenges.

Treatment Completion Rates: Eight studies reported on treatment completion or success rates. The findings were mixed, with some studies showing improvements and others finding no significant difference. Three studies found significant improvements in treatment success with digital interventions. Story et al.[18] reported that VOT was significantly more effective than DOT in achieving treatment outcomes. Iribarren et al.[36] demonstrated higher treatment success rates with the TB Treatment Support Tools (TB-TSTs) intervention compared to usual care. Park et al.[42] found that integrated patient management using a "smart pillbox" effectively improved TB treatment outcomes in Morocco. Conversely, five studies found no significant difference in treatment completion rates compared to standard care. Louwagie et al.[31] observed no significant differences in treatment success rates between the ProLife intervention and usual care in South Africa. Manyazewal et al.[32] found no

significant impact on treatment outcomes despite the non-inferiority of mobile electronic medication adherence technology (MERM) to in-person DOT in Ethiopia. Liu et al.[33] reported that digital adherence technologies did not significantly affect primary outcomes, including treatment completion, in their large-scale study in China. Chen et al.[38] noted that 99DOTS did not significantly improve TB treatment outcomes despite widespread adoption in India. Kumwichar et al.[35] found no statistically significant difference in sputum conversion rates between VOT (73%) and DOT (61.5%) groups ($p = 0.17$) in Thailand, although they did observe improvements in compliance days.

Secondary Outcomes:

It is noteworthy that none of the included studies explicitly reported on patient knowledge or quality of life outcomes. This gap in reporting highlights a need for future research to address these important patient-centered outcomes in the context of digital interventions for TB care

a. Patient knowledge: No studies explicitly reported on changes in patient knowledge.

b. Quality of life: No studies explicitly reported on quality-of-life outcomes.

c. Cost-effectiveness: Two studies reported on cost-effectiveness. The study by Thompson et al.[29] found varying costs per treatment success for 99DOTS implementation, suggesting potential cost savings in certain scenarios. Lam et al.[45] demonstrated the cost-effectiveness of video directly observed therapy (VDOT) technologies in TB treatment.

d. Patient satisfaction: Five studies reported on patient satisfaction or acceptability. Generally, people with pulmonary tuberculosis found digital interventions acceptable and satisfactory. For example, Musiimenta et al.[27] reported high acceptability of SMS reminders and incentives, while Do et al.[44] found that VDOT enhanced the comfort of people with pulmonary tuberculosis in using mobile phone features for medication adherence.

GRADE assessments showed moderate certainty for treatment adherence, low certainty for treatment completion rates, and low to moderate certainty for cost-effectiveness and patient satisfaction due to inconsistencies and limited study numbers, see summary in **Table 1.**

Table 1. Summary of the main outcomes across studies

Outcomes	Number of studies	Summary of findings	Certainty of evidence (GRADE)
Treatment adherence	10	6 studies found significant improvements with digital interventions; 4 studies found no significant difference or mixed results.	Moderate
Treatment completion rates	8	3 studies found significant improvements; 5 studies found no significant difference.	Low to moderate
Patient knowledge about TB and self-care	0	No studies explicitly reported on this outcome.	Very low
Quality of life	0	No studies explicitly reported on this outcome.	Very low
Cost-effectiveness of interventions	2	Both studies suggested potential cost-effectiveness of digital interventions.	Moderate
Patient satisfaction with care	5	All studies reported high patient satisfaction or acceptability of digital interventions.	Moderate

Implementation Challenges and Facilitators

Seven studies examined implementation challenges and facilitators.[27,28,30,37,38,44,46] Key challenges included technological barriers, such as difficulties using smartphones and unreliable connectivity in rural areas,[28,37,38] privacy concerns about health information,[28] and maintaining long-term patient engagement.[37,38] Logistical issues with integrating new technologies into existing practices were also noted.[30]

Facilitators for successful implementation included user-friendly design, customization to local contexts, and adequate training and support for healthcare workers and patients.[30,44,46] Integration with existing healthcare systems, incentives like mobile money, and using human-centered design principles also enhanced adoption.[27,28,30,46] Interventions showing cost savings or efficiency improvements were more likely to be sustained.[29,45] These findings highlight the need to address both technical and human factors in digital TB interventions.

Discussion and Implications for Nursing

This systematic review was grounded in the Chronic Care Model (CCM) adapted for tuberculosis (TB) care.[49-51] The CCM emphasizes patient-centered care, support for self-management, and the integration of health information technology to enhance outcomes for chronic diseases.[21] In the context of TB, digital interventions align with this model by empowering people with pulmonary tuberculosis, enhancing communication with healthcare providers, and supporting adherence to long-term treatment regimens.[52] This review adhered to the PRISMA guidelines for systematic reviews. Standardized tools assessed study bias, and the GRADE approach evaluated evidence certainty, enhancing the reliability and transparency of our findings. The varying quality of the studies affected the overall certainty of evidence for different outcomes. For treatment adherence, six out of ten studies reported significant improvements with digital interventions compared to standard care, particularly with smartphone-based VOT, and MERM had a moderate rating for evidence certainty, reflecting confidence in the findings but acknowledging some limitations, such as study design heterogeneity and potential bias. These results align with a previous study that demonstrated the superiority of smartphone-enabled VOT over directly observed treatment in a randomized controlled trial.[18]

However, the mixed results across studies suggest that the effectiveness of digital interventions may be context-dependent. This variability mirrors the previous findings reported diverse outcomes in their review of digital health technologies for TB treatment.[19] The inconsistency in results underscores the need for careful consideration of local factors when implementing digital interventions, highlighting the moderate certainty of evidence due to the influence of these variables.

The evidence for improved treatment completion rates was less conclusive, with only three out of eight studies reporting significant improvements. The evidence certainty for this outcome was rated as low to moderate, reflecting concerns about study quality, small sample sizes, and variability in outcome measures. This discrepancy between adherence and completion rates suggests that while digital interventions may enhance day-to-day medication adherence, other factors likely influence overall treatment success. These could include socioeconomic determinants, comorbidities, or healthcare system capacity, as highlighted by the Stop TB Partnership in their analysis of TB care challenges.[53]

The role of nurses in implementing digital interventions for TB care emerged as a crucial theme in our review. Nurses, as frontline providers, are crucial for the effective integration of digital tools into TB management. Several studies highlighted the potential of digital interventions to support and enhance nursing practice in TB care. For instance, mobile health applications were found to assist nurses in delivering more efficient and personalized care, particularly in community settings.[26] These tools enabled nurses to remotely monitor patient adherence, manage side effects, and provide timely support, aligning with the CCM's emphasis on proactive care and self-management support.

However, the implementation of digital interventions also presented challenges for nursing practice. Some studies reported increased workload for nurses, particularly during the initial implementation phase, as they had to learn new technologies and integrate them into their existing workflows.[25] This finding underscores the need for adequate training and support for nurses when introducing digital interventions. The review highlighted the essential role of nurses in designing and implementing digital interventions, ensuring they are practical and acceptable in clinical settings.

The review results indicate the potential benefits of digital interventions in TB care, but their generalizability is limited by context variability. Effectiveness varied across settings, with smartphone-based interventions performing well in urban areas with good internet but potentially less applicable in rural or low-resource settings. Patient satisfaction with digital interventions was high in all five studies, though evidence certainty was moderate due to potential self-report bias. This positive feedback reinforces the use of digital tools to boost patient engagement in TB care, aligning with the principles of the Chronic Care Model (CCM). Cost-effectiveness, reported in two studies, also showed potential economic benefits, but evidence was moderate and limited. Further robust economic evaluations are needed to confirm these findings and guide policy decisions, especially in resource-constrained settings.[17]

Our findings suggest that integrating digital interventions into TB care aligns with the CCM and supports treatment adherence. However, effectiveness varies by context, requiring adaptable policies tailored to local needs. Healthcare systems should evaluate their technology, workforce, and patient preferences, ensuring adequate training for effective use. The high patient acceptability highlights the potential for enhancing engagement and empowerment, but policies must also address barriers to access to avoid worsening health inequities.

This review identified several implementation challenges, including technological barriers and privacy concerns. These challenges emphasize the importance of considering local contexts and infrastructure when implementing digital interventions. Future research should explore strategies to address these barriers and ensure equitable access to digital health solutions, as highlighted by Falzon et al.[54] in their review of digital technologies for TB care.

The relevance of our findings to nursing practice may vary based on the specific roles and responsibilities of nurses within different healthcare systems. In some settings, nurses may have greater autonomy in managing TB care and implementing digital interventions, while in others, their role may be more limited. This variability underscores the importance of considering local nursing practices and healthcare system structures when applying our findings to specific contexts.

The intervention and outcome measure diversity prevented meta-analysis, limiting quantitative conclusions. The absence of data on patient knowledge and quality of life highlights significant gaps. Recommendations include: 1) Long-term studies on treatment completion and relapse rates, 2) Research on impacts on patient knowledge, empowerment, and quality of life, 3) Studies on effectiveness factors in various contexts, 4) Robust cost-effectiveness analyses, and 5) Qualitative research on patient and provider experiences for user-centered design.

Conclusions

Patient-centered digital interventions show promise in improving treatment adherence for pulmonary tuberculosis, with high patient acceptability. However, their impact on treatment completion rates is less clear. The effectiveness of these interventions appears to be context-dependent, highlighting the need for tailored implementation strategies. While digital interventions represent a valuable tool in TB care, they should be seen as part of a comprehensive approach that addresses the multiple factors influencing TB treatment outcomes.

The role of nurses in implementing and optimizing these digital interventions is crucial. Nurses, as frontline providers, are uniquely placed to ensure digital tools complement, rather than replace, the human aspects of TB care. Future research and policy efforts should prioritize supporting nurses in this evolving role, acknowledging their potential to drive innovation and enhance TB care outcomes through the effective use of digital health technologies.

Acknowledgement

We sincerely thank Universitas Airlangga for granting access to the databases crucial for conducting the literature search in this systematic review.

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Appendix

Table A1. SYNTAXIS PubMed

(“tuberculosis pulmonary”[All Fields] OR “pulmonary tuberculosis”[All Fields] OR “lung tuberculosis”[All Fields]) AND ((y_5[Filter]) AND (ffrft[Filter]) AND (english[Filter]))	4,228
(“Telemedicine”[All Fields] OR “Mobile Applications”[All Fields] OR “Cell Phone”[All Fields] OR “computers handheld”[All Fields] OR “Internet-Based Intervention”[All Fields] OR “Telemedicine”[MeSH Terms] OR “Telemedicine”[All Fields] OR “telemedicine s”[All Fields] OR “mhealth s”[All Fields] OR “Telemedicine”[MeSH Terms] OR “Telemedicine”[All Fields] OR “mhealth”[All Fields] OR “Telemedicine”[MeSH Terms] OR “Telemedicine”[All Fields] OR “ehealth”[All Fields] OR “mobile health”[All Fields] OR “digital health”[All Fields] OR “mobile app*”[All Fields] OR “smartphone app*”[All Fields] OR “text messag*”[All Fields] OR “smart mater struct”[Journal] OR “sms”[All Fields] OR “short message service”[All Fields] OR “digital intervention*”[All Fields] OR “web-based”[All Fields] OR “internet-based”[All Fields] OR “online intervention*”[All Fields]) AND ((y_5[Filter]) AND (ffrft[Filter]) AND (english[Filter]))	66,270
(“self care”[All Fields] OR “Patient-Centered Care”[All Fields] OR “Medication Adherence”[All Fields] OR “self care”[All Fields] OR “self care”[All Fields] OR “patient-centered”[All Fields] OR “patient-centred”[All Fields] OR “treatment adherence”[All Fields] OR “Medication Adherence”[All Fields]) AND ((y_5[Filter]) AND (ffrft[Filter]) AND (english[Filter]))	29,822
#1 AND #2 AND #3 AND ((y_5[Filter]) AND (ffrft[Filter]) AND (english[Filter]))	9
#1 AND #2 AND ((y_5[Filter]) AND (ffrft[Filter]) AND (english[Filter]))	35

https://pubmed.ncbi.nlm.nih.gov/advanced/

Table A2. Key characteristics of the included studies

No.	Author (year), country	Study design	Sample size & population characteristics	Intervention type, duration, and comparator	Primary outcome measured	Key findings
1.	Musiimenta A, Tumuhimbise W, Mugaba AT, et al. (2024), Uganda	Mixed methods feasibility and acceptability study	39 tuberculosis patients (≥ 18), within 4 weeks of starting TB treatment, mobile phone users, SMS-capable, living in Mbarara district	Digital Adherence Technologies (My Mobile Wallet): real-time monitoring, SMS reminders, and mobile money incentives for 6 months	Feasibility and acceptability of My Mobile Wallet intervention	SMS reminders and incentives were highly feasible and acceptable, with high transmission success rates for adherence data, fostering participant support and medication adherence.
2.	Louwagie G, Kanaan M, Morojele NK, et al. (2022), South Africa	Multicentre, randomised controlled trial	574 adults starting treatment for drug-sensitive pulmonary TB, tobacco smokers or hazardous alcohol users	ProLife intervention (3 motivational interviewing sessions + SMS) vs. usual care, over 6-9 months	TB treatment success rate at 6-9 months	No significant differences in treatment success rates or secondary outcomes between intervention and control groups were observed, suggesting limited impact of the intervention on TB treatment outcomes.
3.	Burzynski J, Schluger NW, Gaeddert M, et al. (2022), USA	Randomized noninferiority trial	216 participants with physician-suspected or bacteriologically confirmed TB	Electronic DOT vs. in-person DOT, crossover design with each method used for 20 doses	Percentage of medication doses observed to be completely ingested	Electronic DOT was found to be just as effective as in-person DOT regarding medication adherence, with both methods achieving high rates of dose completion.
4.	Manyazewal T, Woldeamanuel Y, Holland DP, et al. (2022), Ethiopia	Multicenter randomized controlled trial	114 adults with drug-sensitive pulmonary TB, newly or previously treated, bacteriologically confirmed	MERM device-observed self-administered therapy vs. in-person DOT during a 2-month intensive phase	Individual-level percentage adherence and sputum smear conversion after 2 months	Mobile electronic medication adherence technology (MERM) showed non-inferiority to in-person DOT, with potential superiority in managing non-ingested doses, but no significant impact on treatment outcomes was observed.
5.	Liu X, Thompson J, Dong H, Sweeney S, Li X, Yuan Y, et al. (2023), China	Cluster-randomised superiority trial	3074 patients across 24 counties/districts in China	Daily reminder monitor, monthly adherence review, and differentiated care vs. routine care over 18 months	Composite outcome: death, loss to follow-up, treatment failure, switch to MDR-TB treatment, or recurrence by 18 months	Digital adherence technologies did not significantly affect primary outcomes compared to standard care, indicating limited effectiveness in improving treatment outcomes despite technology use.

Table A2. Key characteristics of the included studies (Cont.)

No.	Author (year), country	Study design	Sample size & population characteristics	Intervention type, duration, and comparator	Primary outcome measured	Key findings
6.	Story A, Aldridge RW, Smith CM, et al. (2019), UK	Multicentre, randomised controlled superiority trial	226 patients with active pulmonary or non-pulmonary TB, eligible for DOT	Video-observed therapy (VOT) using a smartphone app vs. directly observed treatment (DOT) 3-5 times per week, over 2 months	Completion of ≥ 80% scheduled treatment observations over first 2 months	Video-observed therapy (VOT) was significantly more effective than DOT in achieving treatment outcomes, with higher adherence rates and fewer adverse events reported.
7.	Kumwichar P, Prappre T, Chongsuvivatwong V. (2024), Thailand	Cluster randomized controlled trial	Pulmonary TB patients in Hat Yai and Meuang Songkhla districts, Southern Thailand	Video-observed therapy (VOT) vs. community-based directly observed therapy (DOT)	Mean cumulative compliance days during intensive phase of TB treatment	Smartphone-based video-observed therapy (VOT) significantly increased the average number of compliance days for both patients and observers compared to community-based directly observed therapy (DOT), with a mean difference of 15.2 days (95% CI 4.8-25.6; $p = 0.005$) for patients and 21.2 days (95% CI 13.5-28.9; $p < 0.001$) for observers. However, the difference in sputum conversion rates between the VOT group (73%) and the DOT group (61.5%) was not statistically significant ($p = 0.17$).
8.	Iribarren SJ, Milligan H, Chirico C, Goodwin K, Schnall R, Telles H, et al. (2022), Argentina	Parallel-designed randomized controlled trial	Newly diagnosed TB patients from Buenos Aires province	TB Treatment Support Tools (TB-TSTs) intervention (mobile app, urine test, treatment supporter interaction) vs. usual care	Feasibility, acceptability, treatment outcomes	TB-TSTs demonstrated higher treatment success rates compared to usual care, with high participant engagement and satisfaction with the intervention's usability.

Table A2. Key characteristics of the included studies (Cont.)

No.	Author (year), country	Study design	Sample size & population characteristics	Intervention type, duration, and comparator	Primary outcome measured	Key findings
9.	Thomas BE, Kumar JV, Chiranjeevi M, et al. (2020), India	Comparison study	597 Indian patients with tuberculosis	Evaluation of 99DOTS (cellphone-based strategy) vs. urine isoniazid testing	Adherence to TB medications	99DOTS exhibited suboptimal accuracy in measuring adherence, particularly in TB, highlighting challenges in engagement and reliability of digital adherence technologies.
10.	Musiimenta A, Tumuhimbise W, Mugaba AT, et al. (2019), Uganda	Mixed methods study	35 TB patients from Mbarara Regional Referral Hospital	Digital adherence intervention with a monitor and SMS reminders	Patients' perceptions of digital adherence intervention	Participants found that the digital adherence intervention, including a digital monitor and SMS reminders, improved medication adherence by providing timely reminders and managing complex medication schedules, demonstrating their commitment to adherence.
11.	Thompson RR, Kityamuwesi A, Kuan A, Oyuku D, Tucker A, Ferguson O, et al. (2022), Uganda	Pragmatic, stepped-wedge randomized trial	Implemented at 18 clinics in Uganda	99DOTS digital adherence technology	Cost and cost-effectiveness of 99DOTS for TB treatment support	Cost-effectiveness analysis of 99DOTS implementation showed varying costs per treatment success, suggesting potential cost savings with extended activities and marginal clinic scenarios.
12.	Wei X, Hicks JP, Pasang P, et al. (2019), Tibet	Multicentre, parallel-group, individually randomised controlled trial	New pulmonary TB outpatients from Shigatse, Tibet	Electronic monitors (e-monitors) with smartphone app vs usual care	Rate of poor adherence (missing ≥ 20% of doses in a month)	The use of e-monitors equipped with voice reminders and app connectivity was designed to enhance treatment adherence in TB patients. These interventions are currently under evaluation for their feasibility, effectiveness, and cost-effectiveness.
13.	Chen AZ, Kilaru A, Subbaraman R, et al. (2023), India	Pre-post study	Adults with drug-sensitive TB in Himachal Pradesh, India	Implementation of 99DOTS digital adherence technology	Favorable treatment outcomes (cured or treatment complete)	Although 99DOTS has been widely adopted, it did not lead to significant improvements in TB treatment outcomes, suggesting that its effectiveness may vary across different settings and populations.

Table A2. Key characteristics of the included studies (Cont.)

No.	Author (year), country	Study design	Sample size & population characteristics	Intervention type, duration, and comparator	Primary outcome measured	Key findings
14.	Santra S, Basu S, Jana S, Mandal A, Mandal S. (2021), India	Quasi-experimental study	220 newly diagnosed TB patients in Delhi, India	mHealth intervention package for 90 days vs. standard DOTS therapy	Medication adherence measured using the Morisky, Green, and Levine Adherence Scale	mHealth intervention significantly improved medication adherence among TB patients on DOTS therapy, suggesting potential for enhancing treatment adherence in similar settings.
15.	Guo XJ, Min HJ, Pang MC, et al. (2020), China	Usability study	158 patients in DOT group (retrospective data) and 235 patients in VOT group	Video-observed therapy (VOT) app installed on smartphones vs. routine directly observed therapy (DOT)	Treatment adherence, treatment discontinuations, patient preferences, healthcare worker attitudes	VOT demonstrated significantly higher observed doses and lower treatment discontinuations compared to DOT, indicating its feasibility and acceptance among patients and healthcare workers.
16.	Holzman SB, Zenilman A, Shah M (2019), India	Single-arm, prospective feasibility study	25 patients in Pune, India	Video directly observed therapy (vDOT) using smartphones	Adherence (percentage of prescribed doses monitored via video) and verifiable fraction (percentage of doses confirmed through video or verbal confirmation)	Video directly observed therapy (vDOT) showed feasibility and acceptability in resource-limited settings, supporting its potential as an alternative to traditional DOT.
17.	Do D, Garfein RS, Cuevas-Mota J, Collins K, Liu L (2019), USA	Longitudinal study	120 participants receiving antituberculosis treatment	Video directly observed therapy (VDOT) app	Change in comfort with mobile phone use (calls, photos, video recording, messaging, internet, and email)	VDOT app enhanced patients' comfort in using mobile phone features for medication adherence, suggesting broader applicability of mHealth apps in healthcare settings.
18.	Patel D, Srinivasan K, Hasselberg M, et al. (2020), Uganda	Qualitative study using human-centered design	Health workers (n = 52), patients (n = 7)	Adaptation of 99DOTS digital adherence technology	Iterative adaptation of 99DOTS based on human-centered design principles	Optimization of 99DOTS in Uganda through human-centered design highlighted improvements in usability and patient engagement, potentially enhancing treatment outcomes.

Table A2. Key characteristics of the included studies (Cont.)

No.	Author (year), country	Study design	Sample size & population characteristics	Intervention type, duration, and comparator	Primary outcome measured	Key findings
19.	Lam CK, Fluegge KR, Macaraig M, Burzynski J. (2019), New York City	Retrospective economic evaluation using program data	Not applicable	Cost analysis of various types of directly observed therapy (DOT) for tuberculosis	Cost savings from using video directly observed therapy (VDOT)	Micro-costing evaluation demonstrated cost-effectiveness of VDOT technologies in TB treatment, emphasizing potential economic benefits in program implementation.
20.	Park S, Moon N, Oh B, Park M, Kang K, Sentissi I, Bae SH. (2021), Morocco	Observational study	3605 TB patients in Morocco's five prefectures	Integrated patient management through a patient-centered, community-based approach utilizing mobile health technology	Treatment adherence, success rate, and lost-to-follow-up rate	Integrated patient management with a "smart pillbox" effectively improved TB treatment adherence and outcomes, suggesting a viable approach for resource-constrained settings.

การช่วยเหลือทางดิจิทัลที่เน้นผู้ป่วยเป็นศูนย์กลางเพื่อความสามารถในการดูแลตนเองของผู้ป่วยวัณโรคปอด : การทบทวนอย่างเป็นระบบ

Anis Rosyiatul Husna, Nursalam, Abdul Aziz Alimul Hidayat, Makhfudli*

บทคัดย่อ: วัณโรคยังคงเป็นปัญหาสุขภาพระดับโลกที่สำคัญ การปฏิบัติของผู้ป่วยตามแผนการรักษาถือเป็นสิ่งสำคัญสำหรับผลลัพธ์เชิงบวก การทบทวนอย่างเป็นระบบนี้ประเมินประสิทธิภาพของการช่วยเหลือทางดิจิทัลที่เน้นผู้ป่วยเป็นศูนย์กลาง (เช่น แอปสุขภาพบนโทรศัพท์มือถือ การแจ้งเตือนทางระบบส่งข้อความสั้น การบำบัดด้วยการสังเกตผ่านวิดิทัศน์) ในการส่งเสริมพฤติกรรมการดูแลตนเองของผู้ป่วยวัณโรคปอด และระบุความท้าทายในการนำไปปฏิบัติ การทบทวนงานวิจัยนี้เลือกการศึกษาที่ตีพิมพ์ระหว่างปี พ.ศ. 2562 ถึง 2567 จาก 6 ฐานข้อมูลตามกรอบแนวทางการรายงาน PRISMA งานวิจัยที่เข้าเกณฑ์ได้แก่ งานวิจัยในผู้ใหญ่ที่เป็นวัณโรคปอด ใช้รูปแบบการช่วยเหลือทางดิจิทัล และรายงานผลลัพธ์เกี่ยวกับการปฏิบัติตามแผนการรักษา อัตราการรักษาครบ ความรู้ของผู้ป่วย คุณภาพชีวิต ความคุ้มทุน และความพึงพอใจ การออกแบบการศึกษาประกอบด้วยการทดลองแบบสุ่มที่มีกลุ่มควบคุม การวิจัยกึ่งทดลอง และการวิจัยเชิงสังเกตที่มีกลุ่มควบคุม ข้อมูลได้รับการสังเคราะห์ในเชิงบรรยายเนื่องจากการช่วยเหลือและผลลัพธ์มีความหลากหลาย

การวิจัยที่ใช้ครั้งนี้มี 20 รายการจาก 12 ประเทศ ประกอบด้วยผู้เข้าร่วมวิจัยกว่า 9,000 ราย ผลการศึกษาพบว่าการช่วยเหลือทางดิจิทัลสามารถทำให้การปฏิบัติตามแผนการรักษาดีขึ้นใน 6 จาก 10 งานวิจัย แต่หลักฐานสำหรับอัตราการรักษาครบนั้นยังไม่ชัดเจน โดยทั่วไปแล้ว ผู้ป่วยรายงานว่าการช่วยเหลือทางดิจิทัลเป็นที่ยอมรับและน่าพึงพอใจ ความท้าทายในการนำผลการศึกษาไปใช้ ได้แก่ อุปสรรคทางเทคโนโลยี ปัญหาการเชื่อมต่อระบบ และความกังวลเรื่องความเป็นส่วนตัว ปัจจัยส่งเสริมได้แก่ การออกแบบที่เป็นมิตรต่อผู้ใช้ การปรับเปลี่ยนตามบริบท และการสนับสนุนที่เหมาะสม การช่วยเหลือทางดิจิทัลที่เน้นผู้ป่วยเป็นศูนย์กลางมีแนวโน้มที่จะเพิ่มการปฏิบัติตามแผนการรักษาสำหรับวัณโรคปอด แต่มีผลไม่ชัดเจนต่ออัตราการรักษาครบ การวิจัยในอนาคตควรศึกษาความท้าทายที่ระบุไว้และสำรวจผลกระทบในระยะยาวต่อความรู้และคุณภาพชีวิตของผู้ป่วย

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คำสำคัญ: การใช้ยาตามแผนการรักษา การดูแลที่เน้นผู้ป่วยเป็นศูนย์กลาง การดูแลตนเอง การทบทวนอย่างเป็นระบบ การแพทย์ทางไกล วัณโรค ปอด

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