Jurnal Ners Volume 9 Nomor 3 Tahun 2025 Halaman 4784 - 4795
JURNAL NERS
Research & Learning in Nursing Science
http://journal.universitaspahlawan.ac.id/index.php/ners

REMOTE DIGITAL SUPPORT FOR ADULTS WITH PULMONARY TUBERCULOSIS: A SYSTEMATIC REVIEW

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Abstract

Remote digital health services, including Video Directly Observed Therapy (VDOT) and Wirelessly Observed Therapy (WOT), offer a promising alternative to traditional Directly Observed Therapy (DOT) for tuberculosis (TB) treatment adherence. This systematic review, following PRISMA guidelines, analyzed 10 randomized controlled trials (RCTs) involving 2,226 participants across seven countries. Results showed remote interventions improved medication adherence by 93% and increased sputum conversion rates to 73%. Most participants (84–100%) preferred digital services due to convenience, reduced travel burden, and better communication with healthcare providers.

Remote digital health enables flexible, patient-centered care, particularly beneficial in areas with limited healthcare access, while addressing barriers of conventional DOT. However, successful implementation depends on robust technological infrastructure, continuous training for healthcare workers, and patient engagement strategies. Further multicenter studies are needed to validate these findings and guide policy adoption.

This review highlights the efficacy and acceptability of remote digital health in TB care, advocating for its integration into treatment programs to enhance compliance and outcomes.

Keywords: *Remote digital health, pulmonary tuberculosis, medication adherence, health risks, health service*

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INTRODUCTION

Pulmonary tuberculosis (TB) remains one of the most challenging global public health challenges, particularly in low- and middle-income countries. According to the World Health Organization (WHO), Indonesia ranked second after India, with 1,060,000 cases recorded with an incidence of 385 per 100,000 population (Kementerian Kesehatan Indonesia, 2023). For more than five decades, direct-to-patient therapy (DOT) has been a standard strategy for TB treatment. However, TB treatment failure was reported to be largely due to the low level of patient adherence to a complex and long-term treatment regimen (Alipanah et al., 2018). Treatment adherence is essential to guarantee the success of therapy, prevent drug resistance, and break the chain of transmission.

According to WHO, approximately 10.6 million new TB cases were reported globally in 2022 (Kementerian Kesehatan Indonesia, 2023). Indonesia accounted for about 10% of these cases, making it the second-highest contributor worldwide after India. This indicates that scale of this problem is extensive and it is also a heavy burden for endemic countries, particularly in Africa and Asia, for example, in Uganda, non-adherence to treatment contributes to low recovery rates and increasing MDR-TB cases. In fact, WHO has set a target to end TB epidemic by 2035, a goal that is challenging to achieve once medication adherence does not addressed immediately (Kementrian Kesehatan Indonesia, 2020). To this point, innovative approaches are indispensable for improving effectiveness and efficiency of TB management.

One potential solution to support TB management was remote digital health, which provides promotive and preventive interventions through information and communication technology. This particular health service enables health professionals to monitor, educate, and support patients through digital media, thereby overcoming geographical barriers and enhancing continuity of care (Ngwatu et al., 2018). Along its development, remote digital health has been used in a variety of chronic disease management programs, including hypertension (Arifin et al., 2024), diabetes (Jannah et al., 2023), and chronic obstructive pulmonary disease (Suraya et al., 2022), with results showing improved medication adherence and patient quality of life.

In Indonesia setting, remote digital health services played a crucial role as an alternative in supporting DOTS (Directly Observed Treatment, Short-course) program, which is currently standard for handling TB (Putri et al., 2018). Meanwhile, study from Uganda reported higher levels of compliance in group of people receiving **Video Directly Observed Therapy (**VDOT). Indeed, VDOT reduced cost and time burden for patients and healthcare workers, while improving convenience (Sekandi et al., 2025). Further, study conducted in Ethiopia documented the use of digital reminders (MERMs) has increased compliance among individuals living with TB (Manyazewal et al., 2022). However, the specific use of remote digital health services interventions in TB management, particularly in improving treatment adherence, has not been systematically studied. This study aims to analyse application of remote digital health among adults with TB

METODE

Design

This study was a systematic review. Remote digital health services in this context covered the usability of communication technology to provide direct monitoring of TB treatment. Material aimed to improve medication adherence were delivered by way telehealth, telemedicine, telenursing, short message service (SMS), video call, and digital sensors. A structured literature search was conducted through a critical assessment of articles found, extracting data, synthesizing and analyzing (Brink & Van der Walt, 2006). This review process is carried out following the guidelines Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to ensure transparency and methodological accuracy in each stage of research (Haddaway et al., 2022).

Search Strategy

Literature search was conducted comprehensively on four (4) databases: Scopus, PubMed, ProQuest, and ScienceDirect. Search strategy to get appropriate article is to use keywords and Medical Subject Headings (MeSH): *("digital health" OR "e-health" OR "telehealth" OR "telemedicine" OR "remote nursing") AND ("medication adherence" OR "compliance" OR "medication management" OR "treatment adherence") AND ("tuberculosis" OR "TB" OR "mycobacterium tuberculosis" OR "pulmonary disease") AND ("patient outcomes" OR "health outcomes" OR "treatment success" OR "patient engagement").*

Eligibility Criteria

A structured approach was adopted to establish the inclusion criteria, guided by the Population (P): Adult patients aged 18 years and older diagnosed with TB clinically and bacteriologically. Intervention (I): Studies involving remote digital health or telemedicine or telehealth for management or monitoring of TB treatment, including telephone consultations, video calls, or messaging applications. Comparator (C): Studies that compare the use of remote digital health services with standard treatment or conventional communication methods (e.g., regular visits to a healthcare facility without remote digital health services). Outcomes (O): Studies that report outcomes related to medication adherence, such as therapy completion rate, timeliness of treatment, or

symptom reduction. A Randomized Controlled Trial (RCT) study published in English from 2015 to 2025. Studies were excluded if they were protocol papers and did not provide interventions in the form of remote digital health.

Study Selection

Results of a comprehensive search in four academic databases found 2525 articles with article details from ScienceDirect (n = 1670), ProQuest (n = 809), Scopus (n = 31) and PubMed (n = 15) databases with 43 articles being published simultaneously using Mendeley. 2482 articles were screened again and 2081 articles were removed because they were outside 2015-to-2025-time frame. A total of 401 articles were further selected for the full text to be taken, 382 articles were screened and issued as many as 382 articles due to inconsistencies in the title and abstract and 19 articles were obtained to be assessed for eligibility. In assessment stage of these 19 articles, 4 articles were excluded because they did not discuss remote digital health services in TB patients, 3 articles were not available in English and 2 articles were not available due to study design inconsistencies. 10 articles were obtained after selection according to inclusion and exclusion criteria, differences found in screening process were resolved by discussion until an agreement was reached between researchers. All process of filtering articles is presented in Figure 1.

Ten studies included in this systematic review were then independently extracted by two researchers using excel to obtain key data in the form of authors, year of publication, country of origin, study design, research variables, type of intervention, instrument used, participant demographic data (such as sample size, number of participants in intervention group by gender, age), details of interventions given between groups, intervener, frequency and duration of interventions delivered and measured outcomes.

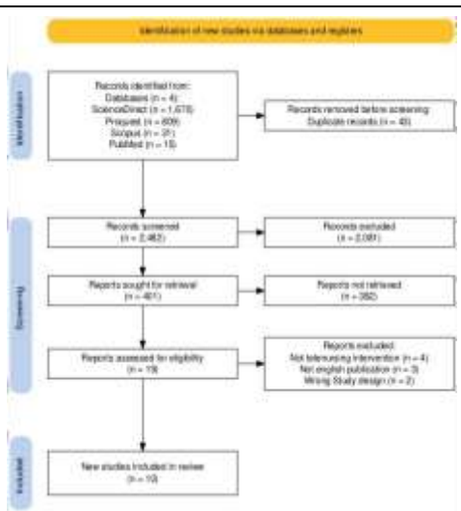

Figure 1. Diagram Flow PRISMA

Methodological quality of each study included in this review was assessed using Critical Appraisal Checklist developed by Joanna Briggs Institute (JBI) in the RCT design study. This checklist allows for a rigorous evaluation of effectiveness of remote digital health services compared to conventional DOT. JBI methodology for RCT study design consisted of 13 question indicators for assessment that included critical aspects such as randomization process, hidden allocation methods, participant and assessor blindness, completeness of follow-up actions, and validity of results and statistical analysis used. Of 10 RCT studies studied, methodological scores varied between 81% to 90%, with majority of studies obtaining a score of 83.3% (5 out of 10 articles where criteria were met). Methodological quality of 10 RCT studies was assessed using JBI criteria. All studies achieved a score of ≥75%, thus meeting inclusion criteria. However, most studies (n=9) did not blind participants or interveners due to overt nature of intervention (e.g., video calls, SMS). In addition, three studies (Bao et al., Bediang et al., Gashu et al.) did not explain concealment allocation, potentially increasing the risk of selection bias. However, Intention–to–Treat analysis and the use of objective measurement tools (such as WOT sensors, video recordings) reinforce the validity of findings. Results of assessment was written in Table 1.

Table 1. Summary of quality of included studies

Author, Year	JBI Score	Criteria met	Main disadvantages	Results
(Bao et al., 2022)	81 %	9/11	Allocation is unclear,blinding is not done	Include
(Browne et al., 2019)	84,6 %	11/13	Blinding is not done	Include
(Guo et al., 2020)	85 %	11/13	Blinding is not done	Include
(Burzynski et al., 2022)	83,3 %	10/12	Blinding is not done	Include
(Johnston et al., 2018)	83,3 %	10/12	Blinding is not done	Include
(Bediang et al., 2018)	90 %	10/11	Unclear allocation	Include
(Kumwichar et al., 2024)	83,3 %	10/12	Blinding is not clear	Include
(Gashu et al., 2021)	81 %	9/11	Unbalanced baseline,unclear blinding	Include
(Sekandi et al., 2025)	83,3 %	10/12	Unclear follow-up	Include
(Manyazewal et al., 2022)	83,3 %	10/12	Unclear follow-up	Include

Note: Minimum Inclusion Score: 75% (all studies meet).
Frequently Unmet Criteria:

a. Blinding (participants/interveners): 9/10 studies did not blind (due to the nature of the open intervention).

b.Clear Random Allocation: 3 studies (Bao, Bediang, Gashu) did not describe the concealment method. c. Baseline Balance: 2 studies (Gashu, Maryazewal) reported baseline differences

RESULT AND DISCUSSION

Characteristics of selected studied

Ten studies involved in this review were conducted in the USA, Canada, Cameroon, Ethiopia, Uganda, China and Thailand. The number of participants varied from 77 (Bao et al., 2022) to 405 (Guo et al., 2021). Majority of participants were male (e.g.: 64/112 in Bao et al., 2022), except Johnston et al. (2018). This particular of study involved more women (196 vs. 161 men). Overall, articles reviewed have a Randomized Control Trial (RCT) design with variations such as non-inferiority RCTs and cluster RCTs. This approach allows for a rigorous evaluation of effectiveness of remote digital health services compared to DOT. All included studies have met minimum score requirement of 75%, which means good quality.

Risk of Bias

Risk of bias in studies was assessed based on methodological quality, including randomization, *blinding*, and *attrition* rates. Six studies used explicit randomization, although some do not provide the mechanism in detail. *Blinding* participants and researchers is difficult to apply to technology-based interventions, increasing the risk of performance bias and detection. Significant *drop-out* rates, such as 21% in VDOT group in Thailand (Kumwichar et al., 2024), as well as reliance on self-report in outcome measurement, are potential sources of bias. However, majority (n=9) of studies reported primary and secondary outcomes comprehensively, reducing the risk of selective reporting.

Characteristics of TB Patients

Eight studies involved patients with an advanced phase of treatment while the rest of two, the Johnston et al. (2018) and Kumwichar et al (2024) focused on latent TB. Age of participants ranged from 16 to 89 years, the majority being in the young to middle-aged group. All studies accessed technology through smartphones. Seven (n=7) were targeting urban areas in Uganda, Ethiopia, and the USA. Detailed characteristics of study participants can be seen in Table 2.

Types of Remote Digital Health Services

Remote digital health services interventions covered (1) *Video-Based Observation (eg. VDOT):* Patients record themselves taking medication through a smartphone application, which is then sent to health workers for monitoring. This method has been shown to significantly reduce observation time (Guo et al., 2021) and is preferred by patients (Burzynski et al., 2022). (2) *Mobile Health (mHealth):* The use of applications such as WeChat for education and self-monitoring (Bao et al., 2022) and text messages (SMS) as reminders to take medication (Bediang et al., 2018). Although SMS improved reporting of side effects, its impact on compliance was not always significant (Johnston et al., 2018). (3) Digital Sensors: Technologies such as WOT that uses ingested sensors and patches to monitor drug consumption in real-time (Browne et al., 2019), as well as MERM's that record medication times (Manyazewal et al., 2022). (4) Phone/Call: Phone reminders show increased compliance and better relationships between patients and healthcare workers (Gashu et al., 2021).

Duration of intervention

Duration of the intervention varies from 2 months to 12 months, depending on the phase of TB treatment. Studies with shorter durations (2-3 months) generally focused on the intensive phase (Kumwichar et al., 2024, Maryazewal et al., 2022 and Bao et al., 2022), while studies with longer durations (6-12 months) covered the entire treatment period.

Interventionist

Multidisciplinary health workers, with nurses playing a central role in implementation and monitoring, were reported in all included studies. In most studies (n=8), nurses were directly involved as interveners, either in the form of video therapy supervision (VDOT), text messaging (SMS), or the use of digital tools such as MERM. For example, in a study by Sekandi et al. (2025) and Maryazewal et al. (2022), nurses are tasked with training patients to use technology, monitor compliance, and follow up on non-compliant patients. In addition, nurses also act as a liaison between patients and health teams, especially in the context of emotional support and education, as reported by Bao et al. (2022) and Gashu et al. (2021). However, two studies (Guo et al., 2021; Burzynski et al., 2022) did not explicitly mention the role of nurses.

Table 2 Characteristics of included studies

No	Author/ year/ Country /Setting	Type of TB	Type of remote digital health services	Participants				Intervention		Inter vention provider	Frequency and periode of intervention	Follow-up	Outcomes measured and instruments
				Sampel size	Fema le	Male	Mean of age	Experi mental group	With troll				
1	(Bao et al., 2022) China/ Harbin Hospital	Newly diagnosed active pulmonary TB TB patients	ITHBC theory-based mHealth intervention via WeChat	112	64	48	*NA	59	53	Nurses, doctors and pharmacist s	3 times a week for 3 months	Beginning of the intervention and 3 months after the intervention	1. Significant improvements in self-care behaviors, knowledge of TB, social support, and satisfaction in the intervention group were measured using a WeChat app-based questionnaire 2. Results of sputum conversion measurements
2	(Browne et al., 2019) USA/ Divisions of TB Control and Refugee Health, di University of California San Diego (UCSD).	Patients with active phase TB treatment advanced phase	Wirelessly Observed Therapy (WOT): a digital sensor-based system with patches worn on the body and connected to a mobile device	61	35	26	43,1	41	20	Trained health workers/ TB clinic staff	Every day for 1 – 2 weeks in stage 1 to 29 weeks in stage 2	1. For the first 2 - 3 weeks 2. Participant s were observed 12-206 days	1. WOT accuracy (99.3%) vs DOT, measured using Ingestion sensors, wearable patches, mobile devices, dashboard systems for health monitoring 2. Daily compliance: WOT 93% vs DOT 63%, using wearable patches, mobile devices, dashboard systems for health workforce monitoring

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3	(Guo et al., 2020), China /hospital	Bacteriologi cally confirmed pulmonary TB patients	Video Directly Observed Therapy (VDOT) via smartphonephon e	405	121	284	40,2 (experi ment group) 44.3 (control)	203	202	Trained healthcare workers with technical support from Youping Technolog y Co., Ltd. for VDOT platform	Every day according to the time of taking the medication until the treatment is complete.	During the treatment period until the end of treatment	1. Treatment completion rate: insignificant VDOT (96.1%) vs. DOT (94.6%) 2. VDOT (Youping Technology Co.) Application, 3. VDOT observation time 16.5 minutes faster via Video recording 4. Patient satisfaction was higher in the VDOT group 96% 5. Patient satisfaction questionnaire
4	(Burzynski et al., 2022), New York/ Pulmonary TB Clinic	Pulmonary TB Patients with Bacteriologi cal Positive Confirmatio n and Receiving Anti-TB Oral Treatment	Electronic Directly Observed Therapy (eDOT) with two options: Live videoconferenci ng and asynchronous video recording via smartphone with the internet	216	76	140	42 years old	103	113	Trained pulmonary TB clinic health workers	Every day for the initial 40 doses of treatment	Administere d every 20 doses of treatment	1. Percentage of successfully observed dose (patient swallowing complete drug). 2. eDOT (Skype/SureAdhere) platform for video recording 3. Conventional DOT clinical record
5	(Johnston et al., 2018), Canada / TB Clinic	Latent TB Infection (LTBI) patients who started preventive therapy	Weekly two-way SMS via personal/loaned mobile phone	358 (1 orang transge nder)	196	161	43 years old	170	188	Clinic nurse	Weekly SMS every Monday for 6 – 12 months of treatment	12 months after enrollment	1. Completion of therapy (≥80% dose within the allotted time), measured through patient self-report and pill count 2. Health-related quality of life (SF-12) 4. Patient satisfaction (satisfaction questionnaire)

No	Author/ year/ Country /Setting	Type of TB Paru	Type of remote digital health services	Participants				Intervention		Inter vention provider	Frequency and periode of intervention	Follow-up	Outcomes measured and instruments
				Sampel size	Fem ale	Male	Mean of age	Experi mental group	With Troll				
6	(Bediang et al., 2018) Cameroon/ TB diagnosis and treatment centre	Pulmonary TB patient newly diagnosed sputum smear-positive	Daily SMS as a reminder to take medication through a proprietary web	279	114	165	ON	137	142	Researcher s and health workers	Daily SMS for 6 months	2nd, 5th and 6th months of treatment	1. Proportion of recovery (sputum smear-negative in the 6th month). 2. Success of treatment (sputum smear-negative in the 5th month). 3. Patient compliance (using a visual analogue scale of 0–100%). 4. Patient satisfaction level (using the Likert scale)
7	(Kumwich ar et al., 2024), Thailand /*NA	New BTA positive pulmonary TB patient	Smarth phone	128	38 (29, 7%)	90	46.3 – 51.2 years	63	65	Trained healthcare workers	Every day during the intensive phase of treatment (60 days)	Day 61 – 63 with follow-up BTA sputum examination	1. Patient and observer compliance (number of compliance days in 60 days). TH VOT application for recording and uploading videos (VOT). 2. BTA sputum conversion rate through BTA sputum examination in the lab.
8	(Gashu et al., 2021), Ethopia/ puskesmas	Drug-sensitive TB patients advanced phase TB treatment	Telephone	306	147	159	ON	152	154	Researcher s and health workers	Daily reminders and weekly refill reminders for 4 months	4 months after completion of the advanced phase via telephone interview	1. TB treatment adherence, measured by the *11-item version of the Adherence to Refill and Medication Scale* (ARMS). 2. Treatment success (recovery/completion of treatment), measured from clinical records 3. Patient-provider relationship, measured by a 7-item questionnaire

No	Author/ year/ Country /Setting	Type of TB Paru	Type of remote digital health services	Participants				Intervention		Inter vention provider	Frequency and periode of intervention	Follow-up	Outcomes measured and instruments
				Sampel size	Fema le	Male	Mean of age	Experi mental group	With troll				
9	(Sekandi et al., 2025), Uganda / pulmonary TB health clinic	Drug-sensitive pulmonary TB patients (including those who restart treatment)	Smartphone	144	72	72	34 years old	72	72	TB clinic researchers and nurses	Daily reminder SMS and video recording every time I take medication every day for 6 months	In the 2nd, 4th and 6th months	1. Compliance rate (≥80% of the drug dose was videotaped), measured through *the Fraction of Expected Doses Observed* (FEDO). 3. Clinical records for treatment completion outcomes, lost to follow-up, death
10	(Manyaze wal et al., 2022), Ethiopia / health facilities	Pulmonary TB patients who are confirmed bacteriologic al, drug-sensitive	digital medication event reminder and monitor (MERM) **using** the evriMED500 ® **device.**	114	40	74	32.9 years	57	57	Health workers who have been trained in the use of MERM devices	Every day for daily therapy and return to the health facility every 15 days for a two-month refill of medication (intensive phase of TB treatment)	After two months of intensive treatment phase	1. Treatment adherence (compared between MERM and DOT records) and sputum conversion. 2. Isoniazid urine test (IsoScreen™), self-report of adherence, and adverse treatment outcomes (death, loss of follow-up).

Outcome and measurement instruments

Assessment and measurement instruments for the treatment adherence of TB patients used in this study consisted of several instruments, adjusted to the variation in the population and the type of intervention being evaluated. Measurement methods applied in the study were as follows: Medication adherence was measured through several approaches: DOT/VOT **(**Directly Observed Therapy/Virtual Observed Therapy), ARMS Scale (Adherence to Refills and Medications Scale) to measure patient self-compliance and sensor technology using *WOT* and *MERM* to monitor drug consumption objectively (Manyazewal et al., 2022). Clinical outcomes were evaluated through sputum conversion, using indicators of changes in sputum status from positive to negative, and WHO criteria for treatment completion (Bediang et al., 2018)

Key findings

The main findings of this study reveal that remote digital health service such as VDOT, WOT, or SMS are more effective than conventional therapies (DOT) in improving treatment adherence, clinical outcomes, and patient satisfaction. For example, patients who use WOT show a compliance rate of up to 93%, much higher than DOT, which was 63% (Browne et al., 2019). However, not all remote digital methods work well; for example, reminders via SMS had less significant impact on medication adherence (Johnston et al., 2018). In terms of treatment outcomes, patients who were involved in remote digital health service also experienced a higher recovery rate of 73% and achieved sputum conversion compared to 61.5% in the DOT group (Kumwichar et al., 2024). In addition, 84–100% of participants preferred remote digital health service because of convenience (e.g. electronic DOT in the study of Burzynski et al., 2022). Even in terms of efficiency, VDOT was more time-saving, with an average monitoring session of only 16.5 minutes, while traditional DOT took 44 minutes (Guo et al., 2021). These findings further reinforced that remote digital health service were more practical and preferred.

Impact of Digital Health Service

Video-based interventions such as VDOT (Guo et al., 2019; Sekandi et al., 2025) and WOT (Browne et al., 2019) are equal to or even superior to direct observation therapy (DOT), with an accuracy of detecting drug consumption reaching 89.8% and a higher daily compliance rate. MERM (Manyazewal et al., 2022) also significantly improved adherence (79% vs. 10% in the control group). In contrast, two-way SMS intervention (Johnston et al., 2018) showed no significant difference in the completion of latent TB therapy, although the overall adherence rate was high in both groups.

These findings indicate that the effectiveness of remote service depends on the type of technology and its integration with direct monitoring mechanisms.

DISCUSSION

This systematic review aims to evaluate remote digital health services strategies to promote treatment compliance in pulmonary tuberculosis and analyze the role of nurses, the influence of intervention duration, and comparison of outcomes between types of interventions (SMS, telephone, videophone, and digital monitoring tools) through the ten recent articles reviewed. The results of the analysis illustrate that digital health services in the form of technology-based interventions such as mHealth, VDOT, and SMS consistently improves patient adherence. These findings are in line with previous literature conducted by Putri et al., 2018 and Ngwatu et al., 2018, where research by both provides an important foundation on the effectiveness of remote digital health service interventions in TB management.

This study documented that mobile phone feature-based videos are effective in improving compliance. As a substitute for DOT, this particular remote digital health service played a role as a reminder (Putri et al., 2018). However, less information on the comparison between types of interventions while research by Ngwatu et al., 2018 evaluated digital technologies such as SMS, VOT, and medication monitors separately, with the finding that SMS was less significant impact, while VOT and digital monitoring tools showed potential. A study by Ngwatu et al., 2018 did not integrate comparative analysis or factors such as intervention duration and local context(Brian Kermu et al, 2018). Accordingly, duration of intervention for minimum 2 months may be inadequate to assess long-term outcomes, such as those with recurrence or drug resistance

This review demonstrates that remote digital health services significantly enhance TB treatment adherence, with effectiveness varying across digital modalities. Videophone-based interventions, as evidenced by Guo et al. (2021) and Sekandi et al. (2025), achieve treatment completion rates of 96.1% and daily adherence of 93%, equaling or surpassing conventional DOT. The superiority of VDOT stems from its interactive, real-time monitoring capabilities, which combine the rigor of in-person observation with the convenience of remote care reducing logistical barriers for patients and saving time for healthcare providers (Guo et al., 2021; Burzynski et al., 2022). In contrast, SMS (Bediang et al., 2018) and phone calls (Gashu et al., 2021) show more modest improvements (79.1% vs. 66.4% in controls), underscoring the limitation of passive reminders compared to structured, two-way engagement. Similarly, the MERM (Manyazewal et al., 2022)

matches DOT's compliance rates but adds value through flexible remote tracking, aligning with findings that hybrid or interactive tools yield the best outcomes. These results collectively highlight that while remote digital health services matched DOT, the efficacy hinges on interactivity, patient-centered design, and integration into clinical workflows factors critical for scaling TB care sustainably.

Effect of duration of intervention varied from 2 months (intensive phase) to 6–12 months. Short-term (60-day) interventions such as those in Kumwichar et al. (2024) showed increased adherence, but have not evaluated long-term impacts on drug recurrence or resistance. In contrast, a 6-month intervention (Sekandi et al., 2025) was more comprehensive but required greater resources including sustained funding for technology (e.g., video platforms, data plans), trained personnel for extended remote supervision, and systemic coordination to ensure uninterrupted patient follow-up. These resource requirements highlight the trade-off between scalability and long-term effectiveness: while shorter programs may be cost-efficient for initial adherence gains, longer interventions necessitate robust infrastructure and investment to sustain clinical benefits and prevent treatment attrition.

Results in the intervention group as a whole showed improved adherence (mean 80-90%), sputum conversion (73% in VDOT), and patient satisfaction (96% in Guo et al., 2021). However, studies by Johnston et al. (2018) found no significant differences, possibly due to dropout factors or intervention design. These findings highlight the importance of adjusting duration to the TB treatment phase (intensive/advanced) and the capacity of the health system. The advantages of VDOT were flexibility, monitoring accuracy, and cost efficiency. The time and location flexibility offered by VDOT reduces cost burden, while the visual verification capability through video recordings ensures the validity of medication consumption data, can suppress the risk of reporting bias. In addition, the integration of supportive features such as automatic reminders and two-way communication with health workers strengthens the sustainability of the intervention.

Comparison of four types of interventions in improving TB treatment adherence based on the results of this analysis Videophone (VDOT): Most effective with >90% compliance and high patient preference (84–96%), but requires smartphone access and digital literacy (Burzynski et al., 2022). SMS: Easy to implement at low cost, but limited effectiveness (Bediang et al., 2018). Telephone: Improves the patient-nurse relationship (Gashu et al., 2021), but depends on network availability. Digital Monitoring Tools (MERMs): Accurate in dose recording, but expensive and at risk of technical bias (Manyazewal et al., 2022). The findings in this report show consistent improvement in adherence through remote digital health services, in contrast to the results of Ngwatu et al. (2018) who found SMS to be insignificant. This may be due to differences in measurement methods: the studies in this report used a combination of questionnaires and clinical data, while Ngwatu et al. (2018) relied on missed dose reports. However, both sources agree that VOT/VDOT and digital tools (MM/MERM) are more effective than SMS, especially in time and cost efficiency.

This study documented that nurses have an important role in the implementation of remote digital health services. Nurses played three major roles: (1) as educators: nurses trained patients how to use technology (VDOT application, MERM) and provided medication education (Bao et al., 2022). (2) Supervisors: nurses monitor compliance via video, SMS, or digital data (Kumwichar et al., 2024). (3) Liaison: facilitating communication between patients and healthcare teams while addressing non-adherence issues (Johnston et al., 2018). However, several studies (n=2) do not explicitly explain the contribution of nurses, indicating the need to standardize roles in remote digital health services protocols.

Limitation

Limitations in the studies reviewed need to pay attention to the following: First, most studies (n= 4) have samples that are limited to a specific location or time period, such as the Bao et al. (2022) study that only involved patients from Harbin Chest Hospital, China, so the generalization of the findings to the wider population is limited. Second, compliance measurement methods that rely on patient self-reports or digital technologies (such as smartphone apps or sensors) have the potential to cause bias, as seen in the study of Gashu et al. (2021). Third, some studies (n = 4) do not cover the entire phase of TB treatment or do not measure long-term clinical outcomes, such as sputum conversion, so the impact of interventions on patient recovery has not been fully described. In addition, external factors such as the COVID-19 pandemic (Sekandi et al., 2025) and the lack of blinding in the study design (Kumwichar et al., 2024) can also affect the validity of the results.

Socioeconomic barriers and low digital literacy (Putri et al., 2020) may hinder the scalability of videophone-based interventions, particularly in resource-limited settings. Additionally, the predominance of short-duration interventions (e.g., 60-day programs) fails to address sustainability or relapse risks (Ngwatu et al., 2018). These limitations underscore the need for future research with standardized methodologies, larger cohorts, and longer follow-up periods to assess both adherence and clinical endpoints.

Implication for Clinical Practice.

Remote digital health services interventions, such as the WeChat app, video

observation (VDOT), and SMS reminders, improve patient compliance and satisfaction. Nurses and other Healthcare professionals can leverage this technology to monitor patients remotely, reduce workload, and provide more personalized support. Before the implementation of this technology, adequate infrastructure and specific training on the usability and functionality of the stuff are needed. In addition, a technology-based approach can be combined with hands-on mentoring for patients who are less skilled in digital devices.

CONCLUSION

Remote digital health services, particularly delivered through VDOT and other digital tools has demonstrated a beneficial impact on improving TB treatment adherence, with active nurse involvement being a critical factor in its effectiveness. These interventions provide a patient-centred and flexible model of care that can address many of the challenges associated with conventional TB treatment, particularly in resource-limited settings. The integration of technology in TB management not only improves efficiency but also expands the accessibility of healthcare services, particularly in areas with limited resources. However, to fully harness the potential of remote digital health services, further research is warranted. This includes the need for multicenter clinical trials, comprehensive cost-effectiveness analyses, and the development of technological solutions tailored to the needs of remote and underserved populations.

Acknowledgment

Author would like to thank the librarians of Universitas Airlangga, Surabaya, for their further access to the academic database.

Conflict of interest

There is no conflict of interest in conducting this research.

Funding

The author does not receive financial support for the research, writing and/or publication of this article.

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