NAVIGATING BARRIERS: THE NEED FOR INTEGRATED HEALTH INFORMATION SYSTEM FOR TUBERCULOSIS-DIABETES CO-SCREENING

Mencari Arah Mengatasi Hambatan: Kebutuhan Sistem Informasi Terintegrasi Skrining Ganda Tuberkulosis-Diabetes

*Merita Arini[1], **Denny Anggoro Prakoso**[2], **Farid Suryanto**[3], **Arlina Dewi**[1], **Muzaitul Akma binti Mustapa Kamal Basha**[4]

[1]Master of Hospital Administration Study Program, Postgraduate Program, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia
[2]Department of Family Medicine and Community Medicine, Faculty of Medicine and Health Science, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia
[3]Department of Information Systems, Faculty of Applied Science and Technology, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[4]Department of Special Care Nursing, Kulliyyah of Nursing, International Islamic University Malaysia, Kuantan, Malaysia
Correspondence*:
Address: Postgraduate Building, UMY Central Campus, Jl. Brawijaya, Kasihan Bantul, Yogyakarta, Indonesia | e-mail: merita.arini@umy.ac.id

Abstract

Background: Tuberculosis-diabetes mellitus (TB-DM) is a co-epidemic condition representing a double burden for high TB burden countries like Indonesia. Private primary care (PPC) in Indonesia was newly reintroduced to the TB program.
Aims: This study explores the challenges PPC healthcare workers (HCWs) face in implementing TB-DM bi-directional screening and strategies to improve it.
Methods: An explorative qualitative method was used by conducting two-round focus group discussions (FGDs) with HCWs (n=15) from five private clinics in Yogyakarta Special Region Province Indonesia and triangulated with 10 DM patients and the TB program manager from the provincial health office. The data were audio recorded, transcribed verbatim, and subjected to thematic analysis.
Results: HCWs face complex barriers in TB-DM co-screening implementation from patients, HCWs, and health system aspects. An integrated system to remind, support decision-making, report, reduce documentation duplication, monitor, and evaluate co-screening implementation emerged as a potential strategy, although some challenges to deploy.
Conclusion: Albeit health information system (HIS) is promising in enhancing integrated TB-DM screening and management, a comprehensive approach and multisector roles are still needed to overcome impediments to TB-DM bidirectional screening in PPCs.

Keywords: diabetes mellitus, health information system, screening, tuberculosis

Abstrak

***Latar Belakang:** Tuberkulosis-Diabetes Melitus (TB-DM) merupakan kondisi ko-epidemik yang merupakan beban ganda bagi negara-negara dengan beban TB yang tinggi seperti Indonesia. Layanan kesehatan primer swasta (PPC) di Indonesia baru diperkenalkan kembali tentang program pengendalian TB.*
***Tujuan:** Penelitian ini bertujuan untuk mengeksplorasi permasalahan yang dihadapi petugas kesehatan PPC dalam melaksanakan skrining dua arah TB-DM dan strategi untuk mengatasinya.*
***Metode:** Metode kualitatif eksploratif digunakan dengan melakukan diskusi kelompok terfokus (FGD) dua putaran terhadap petugas kesehatan (n=15) dari lima klinik swasta di Provinsi Daerah Istimewa Yogyakarta Indonesia dan melakukan triangulasi terhadap 10 pasien DM dan pengelola program TB dari dinas kesehatan provinsi. FGD direkam secara audio, ditranskrip secara verbatim dan dilakukan analisis tematik.*
***Hasil:** Petugas kesehatan menghadapi hambatan kompleks dalam pelaksanaan skrining dua arah TB-DM dari aspek pasien, petugas kesehatan, dan sistem kesehatan. Terungkap bahwa sistem informasi yang terintegrasi dan menjadi pengingat, mendukung pengambilan keputusan, pelaporan, mengurangi duplikasi dokumentasi, memantau dan mengevaluasi skrining sebagai strategi yang potensial. Namun demikian, terdapat potensi tantangan dalam penerapannya.*
***Kesimpulan:** Meskipun HIS menjanjikan dalam meningkatkan skrining dan manajemen TB-DM yang terintegrasi, pendekatan komprehensif dan peran multisektor masih diperlukan untuk mengatasi hambatan terhadap skrining dua arah TB-DM di PPC.*

***Kata kunci**: diabetes melitus, sistem informasi kesehatan, skrining, tuberkulosis*

Introduction

Tuberculosis (TB) and Diabetes Mellitus (DM) are chronic comorbid conditions that have become crucial global issues (Nicholson *et al.*, 2017; Zwama *et al.*, 2021). DM is a TB risk factor that often complicates and increases the risk of failing TB treatment, causing multidrug resistance and death. On the other hand, people with TB are more susceptible to transient hyperglycemia, which can develop into DM (Leung *et al.*, 2017; Zheng, Hu, and Gao, 2017).

Indonesia is currently ranked 2nd in the number of TB sufferers and 5th in the number of DM sufferers worldwide (International Diabetes Federation (IDF), 2021; World Health Organization, 2023). These two diseases contribute to the burden of morbidity and mortality along with economic and social issues (WHO, 2023). Integrated TB-DM practices have not been implemented routinely and systematically in health facilities in Indonesia (Republic Indonesia Ministry of Health, 2023). The TB-DM collaboration mechanism has not been established in private primary care (PPC), which has different resources and characteristics from the government's (Arini, Sugiyo, and Permana, 2022). This prior research showed that PPCs have not been involved in TB control programs.

Moreover, the national health financing system does not entirely support TB-DM case detection, and there are obstacles from the patients' perspective (Arini, Sugiyo, and Permana, 2022). The high number of patient visits to PPCs has the potential to obtain new TB case findings, especially from vulnerable groups (DM patients) (Surya, Setyaningsih, Nasution *et al.*, 2017; Fuady *et al.*, 2020). Additionally, not all healthcare workers are capable of conducting TB-DM screening (Arini, Ahmad and Utarini, 2020).

Strengthening the system for finding TB cases in the DM patients group has now become one of the priorities in national health programs (Almossawi *et al.*, 2019). Hence, Indonesia government launched The National Strategy for Controlling Tuberculosis in Indonesia 2020-2024 Enhancing the Public Private Mix ((PPM),

PPCs have been reintroduced to TB control (Republic Indonesia Ministry of Health, 2020a). Evidence highlights that not including the private sector in TB causes delays in case discovery, ineffective care, drug resistance, and patient costs (WHO, 2022).

Bottlenecks of healthcare organizations in implementing the TB-DM integrated care system should be identified to ensure that all at-risk patients receive bi-directional screening and are correctly recorded as suggested by previous research and Expanded Chronic Care Model (Barr *et al.*, 2003; Arini, Ahmad and Utarini, 2020). TB-DM co-screening is a valuable global strategy for preventing missed opportunities to identify TB patients and vice versa (Prakoso *et al.*, 2023). Hence, this study aims to explore the obstacles encountered by HCWs on TB-DM bi-directional screening implementation in PPCs and the strategies to resolve them.

Method

This qualitative-explorative study was conducted in February–April 2022 in Yogyakarta Special Region Province, Indonesia. This strategy fits the medical research's complexity. Additionally, this method could investigate unknown and complex themes, provide in-depth insights, and offer new viewpoints that quantitative tools may not capture for facilitating more robust evaluations (Hallingberg *et al.*, 2018; Pyo *et al.*, 2023).

Data were collected from five faith-affiliate private clinics and non-profit orientations. These evaluated clinics have been piloted implementing TB-DM bi-directional screening in three months since this research is part of a large study piloting the implementation of TB-DM collaborative services in PPCs in Yogyakarta Province. They also represented inpatient and outpatient clinics from rural, suburban, and urban areas.

Data collection was conducted by two-round focus group discussions (FGDs). The first FGD (early evaluation) was conducted to evaluate the TB-DM screening implementation with HCWs (n=15) from five clinics. Second, the 5

group mini FGDs were held as secondary evaluation with the same HCWs (n=15). These two data collection cycles were used to assess changes in the situation, including challenges and strategies to improve TB-DM screening. New programs implemented at a particular moment may affect HCW adoption for many reasons in daily service settings (Prakoso *et al.*, 2023). Mini FGD is a data collection method that uses the FGD technique with a small group of participants (2-5) (Nyumba *et al.*, 2018). Mini FGDs can be more engaging and comfortable for participants, potentially increasing information depth and completeness than conventional FGDs (Scheelbeek *et al.*, 2020). Moreover, in low-resource settings, this method can assist in overcoming power dynamics and conversational norms, allowing for more open sharing of personal viewpoints and experiences.

Purposive sampling using the criterion sampling technique was applied. The inclusion criteria for informants involved in FGDs were the TB-DM co-screening implementers, including policymakers in clinics and practitioners. They were selected to provide rich information regarding implementation experiences in their clinics. Hence, HCW participants from each clinic consisted of clinic directors, functional medical doctors, and the persons in charge (PIC) of TB or chronic care from each clinic.

The first and second authors, formally trained as qualitative researchers, collected the data. Meanwhile, the third and fourth authors, with a research background in health systems and health information, acted as observers in the FGDs. Open-ended questions and guidelines for discussions guided the FGDs. Each FGD and interview lasted about 180 minutes and were conducted in Indonesian and local Javanese languages.

The FGD and interview recordings were transcribed verbatim. Trained research assistants followed standard operational procedures to transcribe. Data was organized in nVivo 12+, and inductive thematic analysis was conducted. Qualitative data transcripts were read and reread to find patterns and themes. Data segments are carefully classified and sorted to categorize connected and similar patterns. By grouping and refining, several more thorough theme groupings emerge (Figure 1). The first author conducted the first coding and was evaluated by others.

Multiple methods were applied to ensure trustworthiness (Carter *et al.*, 2014). Data sources were triangulated by: 1) repeated and rephrased questions for informants; 2) four mini FGDs and one in-depth interview with ten DM patients from these five clinics; 3) IDI with the provincial health office TB program manager; 4) cross-confirming informants' responses and reviewing screening implementation data (screening form completion, TB-DM report documents, and medical records). For investigator triangulation, the moderator and other researchers observed FGDs. Transcripts were not given to participants but were rechecked before coding to ensure reliability. To ensure equal data interpretation, those who write reviewed transcript results. We provide protocol thick description and created an audit trail to demonstrate dependability and confirmability. We also employed the COREQ (consolidated criteria for reporting qualitative research) checklist to verify research and reporting quality and robustness (Tong, Sainsbury, and Craig, 2007).

Result and Discussion

Fifteen HCWs from 5 different PPCs attended the FGDs (Table 1). The age range of the participants was 28-44 years, with an average of 32.5 years old. Most of them were female (80.1%), with an average length of employment of 7.2 years (range = 1.5-16 years), and from a multidisciplinary background. The research discovered three primary themes (Figure 1).

Table 1. Socio-demographic characteristics of the participants

Informant's Code	Gender	Age (year)	Job Position	Education	Work Period (year)
I1	F	38	PIC of chronic care program	Undergraduate	6
I2	F	31	Functional MD	Undergraduate	7
I3	F	36	Clinic director	Postgraduate	7
I4	F	28	Clinic director	Undergraduate	2
I5	M	30	Functional MD	Undergraduate	2
I6	F	32	PIC of chronic care program	Diploma	4
I7	F	26	Functional MD	Undergraduate	1.5
I8	F	28	PIC of chronic care program	Diploma	4
I9	F	28	Functional MD	Undergraduate	2.5
I10	M	36	Clinic director	Postgraduate	11
I11	F	42	PIC of chronic care program	Diploma	16
I12	F	31	Functional paramedic	Diploma	8
I13	F	44	Clinic director	Undergraduate	9
I14	F	28	PIC of chronic care program	Diploma	8
I15	F	30	Functional paramedic	Diploma	9

Note: F = female, M = male, MD = medical doctor, PIC = person in charge
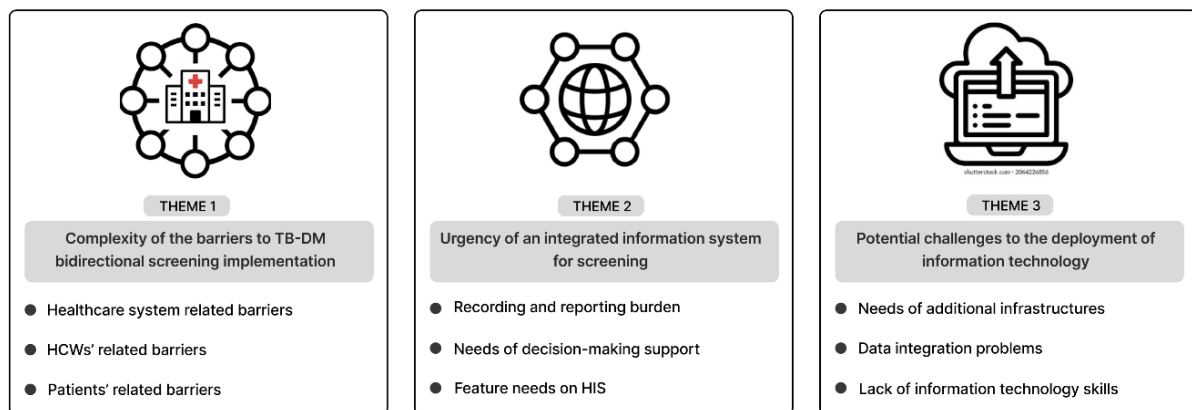

Figure 1. Themes and sub-theme

Theme 1: the complexity of TB-DM bidirectional screening implementation

In this study, five clinics completed at least three months of the pilot implementation of bidirectional TB-DM symptoms-based screening. Several bottlenecks existed in this third month, causing the clinics to adjust the screening methods. The constraints identified in the study encompassed obstacles relating to the health system, healthcare staff, and patients. These adjustments imply variation pathways in their applications.

"… usually, the patient will be screened by the nurse at the registration table. However, if the nurse forgets, usually the doctor will screen it later." (I7)
"During PROLANIS (chronic care program), some geriatric patients were interviewed for screening. Other patients filled out the self-screening form by themselves." (I2)

In line with our study results, some health facilities often adjust the protocols or clinical procedures. Adaptation is inevitable in TB screening when integrated with another disease. The different flow of care, HCWs availability and workload, health examination equipment availability, and patient condition become the factors that

should be considered (Wijiseno, Arini, and Listiowati, 2023).

Healthcare system-related barriers

PPCs faced intricate obstacles as a result of resource constraints. The obstacles in the health system-related barriers from our study include lack of infrastructure, health financing system constraints, and unavailability of EMR. The clinics need more infrastructure to support further TB examinations and care. Although clinics can network with government health facilities, these situations could impede patient management follow-up due to increased patient burden.

"Even if the clinic can carry out a complete examination for TB, we did not yet have facilities for examination of AFB (acid-fast bacillus) and sputum collection booth outside." (I4)

In the health financing system, informants were worried about the performance assessment by BPJS Kesehatan (the national social-health security agency) due to many suspected TB referrals to hospitals.

"When the AFB examination is negative, we still have to pursue further examinations, such as a chest x-ray. So, we must refer patients to the hospital, which will add the referral number because the limit referral ruled out by BPJS is a maximum of 14.4%." (I4)

Informants said screening is often skipped since no system ensures it. Electronic and paper-based medical records (MR) lack a reminder system to encourage HCW screening and have not yet given screening history information. Data management is not integrated yet, so officers must manually recapitulate the report. Moreover, clinics without EMRs find data checking harder. Hence, HCWs often delay MR fulfillment, resulting in inaccurate results.

"There is no warning on the computer. Doctors only asked for complaints that are currently symptomatic, so sometimes the history is not noticed." (I10)
"We recapitulate from both EMR and screening form manually." (I1)

Incomplete MR fulfillment and unintegrated data caused clinical data not to be appropriately analyzed. PPCs also have trouble tracking patient histories due to a lack of data sharing or feedback from other referral health facilities. An excerpt below illustrates these continuity of care problems.

"I asked Puskesmas to share the data about the patient who was sent to us related to infectious diseases, especially the status of hepatitis, TB, or others such as HIV/AIDS … but they did not provide the data transfer." (I4)

Our research indicated that health organizations and the health system's financing, infrastructure, and continuity of treatment issues challenged TB-DM bidirectional screening pilot testing. This finding aligns with the unresolved constraints in Indonesian TB research (Almossawi *et al.*, 2019; Kurniawati, Padmawati, and Mahendradhata, 2019; Arini, Sugiyo and Permana, 2022). Moreover, the problem of patient referral barriers related to single-payer health financing policies (BPJS Kesehatan) in Indonesia still needs to be addressed with a high level of commitment and health financing sources innovations (Collins and Hafidz, 2014; Fuady *et al.*, 2019). Employing alternative health financing mechanisms can serve as a potential solution, although its long-term viability must be taken into account (Dong *et al.*, 2019).

HCW-related barriers

Different numbers and characteristics of patients affect clinics' workloads differently. High staff turnover, a demanding workload due to administrative burdens and patients, varied levels of

Original Research

Indonesian Journal of Health Administration
(Jurnal Administrasi Kesehatan Indonesia)
p-ISSN 2303-3592, e-ISSN 2540-9301
10.20473/jaki.v12i1.2024.162-176

HCWs' commitment, and a lack of HCWs' competency were noticed. Not all HCWs can recognize the signs/ symptoms of TB or perform TB examination techniques.

"Some doctors have many patients, so they are in a hurry. Therefore, it was found that some patients had not been screened." (I7)
"… only female doctors screen TB in DM patients, while male doctors do not." (I1)
"*Our colleagues do not consider that a DM patient with a two-week cough must be screened for AFB.*" (I10)

Our study found that healthcare workers (HCWs) faced awareness, knowledge, workload, and ethics challenges. This situation confirms South African evidence that HCWs availability and capability and the lack of an effective integrated system were the key barriers to delivering integrated TB-DM services in primary care (Almossawi *et al.*, 2019). This finding implies the need for continuing awareness sessions and capacity building (Arini, Primastuti, and Basha, 2024).

The informants reported their acceptability of the piloted screening program. Although, in general, they considered that this new task could still be managed. Some HCWs were uncomfortable with the patients' reactions to screening questions, were not used to conducting them at first, and felt crowded when there were many patients.

"This program is an additional service but is enjoyable and helps people with TB to be detected. Sometimes hurdles make us unsatisfied; therefore, I am responsible for it." (I7)
"It is a bit uncomfortable to meet a patient who refuses to be screened. Forcing him is also not good. When the PROLANIS was hectic, PROLANIS patients in the emergency room were present. There were also polyclinic patients. However, there was only one doctor, so it was a bit confusing." (I7)

HCWs in this study exhibited a positive attitude towards the dual screening procedure despite encountering various obstacles. Research conducted on religiously affiliated private hospitals also demonstrates comparable findings (Wijiseno, Arini, and Listiowati, 2023). Their understanding of existing regulations primarily determines the acceptability of private HCWs, the consistency of interventions and collaboration, and ethical considerations (Kurniawati, Padmawati, and Mahendradhata, 2019).

Patient-related barriers

Because TB is infectious, HCWs often meet patient denial during screening or referral to other health facilities for further TB examinations. TB or COVID-19 stigmatizes coughing. In addition, the characteristics of certain demanding patients add to the pressure placed on HCWs. Some patients or caregivers also skipped routine screenings because they were rushed.

"The patient says, 'I do not have TB; why am I being screened for that?' So, some of them refused to be screened." (I1)
"Sometimes the patient doesn't want to stay too long. For example, it's like he doesn't want to be asked any more questions." (I3)

Our research indicated that patients' perceptions often affect diagnosis flow as healthcare recipients. Many patients refuse referrals for further tests, delaying follow-up or diagnosis. The patient issues that hinder screening necessitate specific health promotion and community empowerment methods (Arini, Sugiyo, and Permana, 2022). On the other hand, to enhance the patients' acceptance of screening, it is necessary to streamline the interventions execution (Chapman and Veras-Estévez, 2021).

Our study revealed that health system, human resources, and patient difficulties impede TB-DM screening in PPCs, preventing all patients from being screened. Malawi and India have low DM screening rates due to various barriers, with

only 24% of TB patients in India examined for DM (Majumdar *et al.*, 2022; Nyirenda *et al.*, 2022). Bidirectional screening in Ghana is hindered by delays, poor patient information, stigma, poor collaboration between TB and DM units, and imbalanced funding (Salifu and Hlongwana, 2020). The cost and complexity of DM screening in low- and middle-income countries make it difficult to diagnose and manage TB-DM comorbidity (Fuady *et al.*, 2019; Salifu and Hlongwana, 2020). TB-DM screening performance, awareness, training, and resource allocation must address these complex hurdles to improve the healthcare system.

Theme 2: the urgency of an integrated information system for screening

Interestingly, HCWs suggested the use of integrated health information system (HIS) for aid bidirectional screening. They complained about the paper-based screening form, unintegrated MR recording and reporting, the requirement of HIS for decision-making support, and several helpful features.

Recording and reporting burden

HCWs are required to report individuals suspected of having TB and the management of patients to the National TB Information System (NTIS). Informants were perplexed by their early introduction to this reporting system. They must familiarize themselves with these application features and recognize when the patient should be reported.

> *"… a was disseminated* (about the national TB information system)*, but we are still confused because it is just the beginning. So maybe it can be studied again."* (I4)

In line with our study findings, researchers found several reasons national reporting systems struggle to report in the NTIS. Problems include lacking human resources, TB program funding, non-integrated HIS, and poor TB recording and reporting flowchart socialization, which hamper optimal reporting (Zhou *et al.*, 2019; Ratnasari and Sjaaf, 2023). Over

25% of TB cases in Eastern China are underreported due to unqualified health workers, insufficient monitoring, and a complex health information management system reporting (Zhou *et al.*, 2019). A study in Zambia also revealed that 32.8% of TB cases were unnotified, and 11.3% were unreported in Zambia (Lungu *et al.*, 2022). Improving resources, training, protocols, and data management systems is essential to increase TB reporting accuracy and global TB monitoring systems.

HCWs must manually record, recapitulate, and assess paper-based piloting TB-DM screening. Some screening forms were incomplete due to administrative tasks. Thus, informants desired an integrated HIS to enhance HCW screening.

> *"The doctors often forget to fill out the recommendation section in the screening form. Maybe it is due to double filling here and MR."* (I4)
> *"The EMR, if possible, has a warning. 'Oh, this patient must be screened for TB."* (I7)
> *"There are many patient data, but I haven't matched the screening results yet."* (I2)

This study suggests a simple and comprehensive system to reduce administrative hassles and promote screening. The Indonesian HIS for recording and reporting TB (Republic Indonesia Ministry of Health, 2020b), does not monitor TB-DM screening or improve its application in everyday practice. A study in South Africa found that low TB-DM screening performance may be due to a lack of reporting responsibility (Almossawi *et al.*, 2019). Meanwhile, mobile and internet-based TB care and control using HIS/technology may improve disease control and surveillance, care administration, and patient outcomes (Aisyah *et al.*, 2020; Ibeneme *et al.*, 2020; Robbiati *et al.*, 2022).

Needs for decision-making support

The HCW participants needed help deciding when to refer the patient for further

Original Research

Indonesian Journal of Health Administration
(Jurnal Administrasi Kesehatan Indonesia)
p-ISSN 2303-3592, e-ISSN 2540-9301
10.20473/jaki.v12i1.2024.162-176

testing or therapy due to typical and overlapping TB symptoms in DM patients. HCWs also require the patient's history and previous well-recorded TB-DM screening results to be considered when referring the patients.

> *"However, we are still confused about TB symptoms in DM patients. Is he just night sweats that need to be referred?"* (I8)
> *"I had an X-ray yesterday at the Puskesmas.' Meanwhile, the doctor did not know his previous history"* (I8)

Clinical decisions, primarily referrals, have procedural and financial consequences. According to our study, symptom-based screening is insufficient for diagnosing TB in DM patients. HIS can evaluate the feasibility and efficacy of peripheral-level DM screening for TB patients and provide frameworks for automated screening of early signs of diseases, which can affect patient outcomes (Setyowati *et al.*, 2020). Since healthcare standards suggest that when patients need GeneXpert or chest X-rays, HIS can help doctors and patients make informed decisions by giving relevant information and weighing the risks and benefits of actions (Brenner *et al.*, 2018; Wang *et al.*, 2023). HIS can aid, but epidemiological research should guide decision-making, which currently lacks strong evidence (Zheng, Hu, and Gao, 2017; Lin *et al.*, 2019). Technology-based TB-DM screening required a more targeted strategy targeting high-risk people, such as those with untreated diabetes or poorly managed hyperglycemia, to maximize resource allocation (Lin *et al.*, 2015).

Feature needs on HIS

HCWs mentioned their need for a simple and easy-to-use HIS to record screening activities. They also underlined the worth of integrating HIS with EMR to decrease redundant documentation, facilitate interpretation, and function as a reminder system to improve continuity of care.

> *"… if possible, the EMR already has a place for screening, so we no longer have to look for paper."* (I7)
> *"It will be more manageable, and the screening coverage can also be recapitulated. It is also easier than paper-based screening. We go straight to it and click and click to fill out the screening results."* (I3)

Our study found that health institutions need a reminder mechanism to encourage all HCWs to check for TB-DM. Despite inconsistent research on notices and reminders, they are necessary to boost screening coverage and promote continuity of care (De Medeiros *et al.*, 2017; Stop TB Partnership, 2018; Aisyah *et al.*, 2020). A Malawian study found that HCW reminders may improve awareness of guidelines/SOP and decision-making competency case management but not compliance (Kaunda-Khangamwa *et al.*, 2018). This literature also found that HIS's reminder system for HCWs and patients needs more policy support, such as human resource arrangements, incentives, monitoring, and feedback (Kaunda-Khangamwa *et al.*, 2018; Stop TB Partnership, 2018).

This study identified the initial requirement for assessments of HIS to enhance screening for comorbidities between TB and other diseases. HIS should be flexible enough for HCWs with or without EMR in their health institutions due to PPCs' EMR availability and preparedness. According to the literature, integrating data programs and NTIS modification is necessary to reduce record duplication and stimulate collaborative implementation (Harries *et al.*, 2015). HIS and EMR features should address duplication documentation, interpretation facilitation, and care continuity. First, unified data entry to reduce repeated paperwork and assure consistency (Pereira *et al.*, 2017)—consolidated HIS and EMR data in comprehensive patient records to give healthcare practitioners correct information. Interoperability automates data sharing, thus less typing (Pellison *et al.*, 2020). Clinical Decision Support Systems (CDSS) improve care continuity by reminding individuals of tasks,

medication schedules, and follow-ups (Armando *et al.*, 2023). Standardized formats and languages simplify data entry and interpretation (Armando *et al.*, 2023). Automation reduces routine activities, enhancing efficiency (de Vries *et al.*, 2021), while a user-friendly interface simplifies data entry and access, improving interpretation and use (Iribarren *et al.*, 2020).

Theme 3: potential challenges to the deployment of information technology

Some clinics studied have not used EMR. Participants felt a computer program or similar technology could help screen and record, but they also noted potential drawbacks. EMR clinics have resource constraints, minimal technology literacy, and the need to integrate existing data.

Needs for additional infrastructure

Informants highlighted the addition of computers, adequate internet signal, and electricity as prerequisites for clinics that have not implemented EMR and are located in suburban or rural areas. HCWs noticed that these conditions had become a financial challenge for still-developing clinics.

"It is challenging to use EMR for the level of a suburban clinic like ours. The first is computer availability. If indeed, God willing, with EMR, there must be a computer at every point of patient care." (I4)
"There will also be electrical problems, whether the power is sufficient because all services must use a computer." (I5)

Data integration problems

The participants highlighted some potential problems related to data and system integration. For clinics that have not implemented EMR, the retention of old patient data should be considered. Some errors in information systems also often happen and need to be solved to ensure healthcare is provided safely.

"I am confused. How to ensure the old patient data in this MR paper is entered into the EMR?" (I5)
"… sometimes the history of previous examinations of old patients cannot be opened." (I10)

Lack of information technology skills

The informant noticed that using new technology means the need for adaptation and training to be beneficial. They pointed out the need for a step-by-step process that takes time and funds.

"We must train IT skills from the beginning because not everyone is capable. We must learn together." (I4)
"If we use EMR, "how could" if we are not used to it. It will take a long time." (I5)

It is interesting to note that although HIS can help HCWs improve TB-DM screening coverage and its reporting, several challenges are also identified in preparing for HIS deployment. Despite informants' needs, suburban and rural PPCs needed help affording computer equipment, internet connectivity, and electrical capacity. These findings indicate that organizational support significantly impacts HIS acceptance (Nugroho, Notobroto, and Rosyanti, 2021). Hence, a flexible, simple, and pleasurable HIS is a necessity to enhance technology adoption (Alshamari, 2016; De Medeiros *et al.*, 2017).

Furthermore, establishing a systematic HIS for TB-DM screening requires a phased approach to better adoption. First, an assessment identifies data gaps and defines essential components, including demographics, risk factors, and treatment history. This study suggests gathering user requirements, potential hurdles, and problem-solving solutions before building a new HIS to ease adoption. Healthcare providers can pinpoint specific gaps in current systems that align with the target population's unique needs, enhancing its effectiveness and relevance in healthcare delivery by

Original Research

Indonesian Journal of Health Administration
(Jurnal Administrasi Kesehatan Indonesia)
p-ISSN 2303-3592, e-ISSN 2540-9301
10.20473/jaki.v12i1.2024.162-176

conducting this needs assessment (Setiyadi and Setyowati, 2022).

When adopting a new HIS, HCWs are concerned about errors and data integration to reduce documentation duplication. Developing HIS for comorbidity screening requires increasing data integration and real-time use. Therefore, data integration across healthcare departments, user-friendly interfaces, and robust data security are the subsequent phase's primary objectives, concentrating on development and implementation (Natsiavas *et al.*, 2018; Bowles *et al.*, 2020). Connecting data from wearable devices, patient portals, and medication adherence requires innovation (Vaz *et al.*, 2022).

Concerning reminder systems needs, the following steps in building a new HIS include considering digital notifications and reminders to be incorporated into HIS workflows through the design process. Decision support systems and intelligent alarms can reduce physician information overload and alert fatigue (Fernandes *et al.*, 2019). Thus, HIS workflows must strategically use digital notifications and reminders to streamline operations, improve collaboration, and optimize screening and follow-up.

Our study showed that HCWs' IT literacy needs to be addressed while adopting technology. To implement successfully, healthcare providers need multi-step training and continuing assistance (Jeyakumar *et al.*, 2021). Staff needs in-depth HIS training, hands-on experience, and scenario-based learning. Troubleshooting, refresher classes, and proactive helpdesk are needed. Successful HIS integration needs early stakeholder participation, continual improvement, and user input for incremental changes (Hariyanto, Denison, and Stillman, 2018). As for advancement, the HIS could identify potential comorbidity risks and trigger real-time interventions with this study's dynamic understanding of a patient's health. Explore artificial intelligence to analyze massive HIS datasets to generate predictive models for comorbidity development, enabling preventative medicine and individualized care (Prioleau *et al.*, 2023).

Finally, Usability testing is also needed when a new HIS is broadly implemented to evaluate how HCWs, as users, can learn, use technology, and overcome various obstacles related to IT and medical case management (Alshamari, 2016). This systematic approach promotes user buy-in and collaboration, resulting in a robust HIS that enhances TB-DM screening efficacy and patient care.

Our study findings reinforce that reducing TB-DM control gaps needs a multifaceted approach along with HIS deployment. Strategic co-infection control training for HCWs and community role in early detection and healthcare support is essential (Arini, Sugiyo, and Permana, 2022). Patients can also actively participate in their care by investing in health education programs (Listiowati *et al.*, 2023). Financial and logistical issues must be addressed through strategic health policies and external collaboration to reduce the TB-DM burden (Lin *et al.*, 2019).

This study has strengths and limitations that should be considered. The strength of this research is that as part of an umbrella study, it was carried out continuously, various sources were used to confirm data, and it was in-depth research due to close engagement with the participants. A limitation worth considering is the contextual nature of the qualitative research, where generalizations may not be possible.

Conclusion

PPCs faced cascade TB-DM screening barriers. Multifaceted approaches and multisector roles were needed to address health organizations, health systems, human resources, and patient challenges. This research supports earlier findings on complicated TB-DM integration barriers in Indonesia's private sector. It supports the private sector's role in future government health programs.

This study suggested building HIS as a reminder, decision-making support, reporting assistance, and monitoring and evaluation to increase screening implementation. However, successful technology implementation requires

Original Research

Indonesian Journal of Health Administration
(Jurnal Administrasi Kesehatan Indonesia)
p-ISSN 2303-3592, e-ISSN 2540-9301
10.20473/jaki.v12i1.2024.162-176

complete HIS preparation and development considering needs, potential impediments, and health organization capability assessments.

HIS cannot solely improve TB-DM collaborative care and control. Complex, multisector actions are needed. Therefore, HIS needs more study to enhance uptake and program coverage. Given Indonesia's diverse health system, further study should focus on a more significant subject.

Abbreviations

AFB: acid-fast bacillus; CDSS: Clinical Decision Support Systems; DM: diabetes mellitus; EMR: electronic medical record; HCW: healthcare worker; HIS: health information system; IT: information technology; MD: medical doctor; MR: medical record; NTIS: National Tuberculosis Information System; PIC: person in charge; WHO: World Health Organization; HCW: healthcare worker; TB: tuberculosis.

Declarations

Ethics Approval and Consent Participant
This study obtained ethical approval from the Health Research Ethics Committee of the Universitas 'Aisyiyah Yogyakarta (No. 1905/KEP-UNISA/XI/2021). All informants underwent written informed consent procedures before data collection.

Conflict of Interest
The authors have no competing interest to declare.

Availability of Data and Materials
Data and material research can be provided upon request.

Authors' Contribution
MA and DAP conceptualized the study and created the methodology; MA and DAP conducted data collection; MA wrote the original draft; MA, DAP, FS, AD, and MAMKB wrote, reviewed, and edited the manuscript.

References

Aisyah, D.N. *et al.* (2020) 'Knowledge, Attitudes, and Behaviors on Utilizing Mobile Health Technology for TB in Indonesia: A Qualitative Pilot Study', *Frontiers in Public Health*, 8(October), pp. 1–9. Available at: https://doi.org/10.3389/fpubh.2020.531514.

Almossawi, H.J. *et al.* (2019) 'Primary Health Care System Readiness for Diabetes Mellitus and Tuberculosis Service Integration in South Africa', *J Trop Dis*, 7, p. 329. Available at: https://www.walshmedicalmedia.com/open-access/primary-health-care-system-readiness-for-diabetes-mellitus-and-tuberculosis-service-integration-in-south-africa-44459.html.

Alshamari, M. (2016) 'Usability Factors Assessment in Health Information System', *Intelligent Information Management*, 08(06), pp. 170–180. Available at: https://doi.org/10.4236/iim.2016.86012.

Arini, M., Ahmad, R.A. and Utarini, A. (2020) 'Tuberculosis and type 2 Diabetes Mellitus (TB-DM) comorbidity care: Barriers from the patients' perspective', *Enfermeria Clinica*, 30(S6), pp. 174–178. Available at: https://doi.org/10.1016/j.enfcli.2020.06.040.

Arini, M., Primastuti, H.I. and Basha, M.A.B.M.K. (2024) 'Improving Knowledge of Non-Communicable Disease Program Managers in Tuberculosis-Diabetes Mellitus Control and Care', *Indonesian Journal of Public Health*, 19(1), pp. 13–25. Available at: https://doi.org/10.20473/Ijph.v19i1.2023.13-25.

Arini, M., Sugiyo, D. and Permana, I. (2022) 'Challenges, opportunities, and potential roles of the private primary

care providers in tuberculosis and diabetes mellitus collaborative care and control: a qualitative study', *BMC Health Services Research*, 22(1), pp. 1–14. Available at: https://doi.org/10.1186/s12913-022-07612-3.

Armando, L.G. *et al.* (2023) 'Clinical decision support systems to improve drug prescription and therapy optimisation in clinical practice: a scoping review', *BMJ Health and Care Informatics*, 30(1), pp. 1–10. Available at: https://doi.org/10.1136/bmjhci-2022-100683.

Barr, V.J. *et al.* (2003) 'The expanded Chronic Care Model: an integration of concepts and strategies from population health promotion and the Chronic Care Model.', *Hospital quarterly*, 7(1), pp. 73–82. Available at: https://doi.org/10.12927/hcq.2003.16763.

Bowles, J.K.F. *et al.* (2020) 'Integrating healthcare data for enhanced citizen-centred care and analytics', *Studies in Health Technology and Informatics*, 275, pp. 17–21. Available at: https://doi.org/10.3233/SHTI200686.

Brenner, A.T. *et al.* (2018) 'Evaluating Shared Decision Making for Lung Cancer Screening', *JAMA Internal Medicine*, 178(10), pp. 1311–1316. Available at: https://doi.org/10.1001/jamainternmed.2018.3054.

Carter, N. *et al.* (2014) 'The use of triangulation in qualitative research', *Methods & Meanings*, 41(5), pp. 545–547. Available at: https://doi.org/10.1188/14.ONF.545-547.

Chapman, H.J. and Veras-Estévez, B.A. (2021) 'Lessons Learned During the COVID-19 Pandemic to Strengthen TB Infection Control: A Rapid Review', *Global Health: Science and Practice*, 9(4), pp. 964–977. Available at: https://doi.org/10.9745/GHSP-D-21-00368.

Collins, D. and Hafidz, F. (2014) *Indonesia TB Financing Roadmap - 25 years from 2015-2039*.

De Medeiros, E.R. *et al.* (2017) 'Clinical information systems for the management of tuberculosis in primary health care', *Revista Latino-Americana de Enfermagem*, 25. Available at: https://doi.org/10.1590/1518-8345.2238.2964.

Developing enhanced tb public- private mix (PPM) data dashboards in high PPM priority countries to ensure action and accountability Meeting report Nairobi , Kenya (2022).

Dong, D. *et al.* (2019) 'Impact of an Innovative Tuberculosis Financing and Payment Model on Health Service Utilization by Tuberculosis Patients in China: Do The Poor Fare Better Than The Rich?', *Infectious Diseases of Poverty*, 8(21), pp. 1–10. Available at: https://doi.org/10.1186/s40249-019-0559-z.

Fernandes, C.O. *et al.* (2019) 'Artificial intelligence technologies for coping with alarm fatigue in hospital environments because of sensory overload: Algorithm development and validation', *Journal of Medical Internet Research*, 21(11), p. 1=20. Available at: https://doi.org/10.2196/15406.

Fuady, A. *et al.* (2019) 'Effect of financial support on reducing the incidence of catastrophic costs among tuberculosis-affected households in Indonesia: Eight simulated scenarios', *Infectious Diseases of Poverty*, 8(1), pp. 1–14. Available at: https://doi.org/10.1186/s40249-019-0519-7.

Fuady, A. *et al.* (2020) 'Cost of seeking care for tuberculosis since the implementation of universal health coverage in Indonesia', *BMC Health Services Research*, 20(1), pp. 1–10. Available at: https://doi.org/10.1186/s12913-020-05350-y.

Hallingberg, B. *et al.* (2018) 'Exploratory studies to decide whether and how to proceed with full-scale evaluations of public health interventions: A systematic review of guidance', *Pilot and Feasibility Studies*, 4(1), pp. 1–12. Available at:

https://doi.org/10.1186/s40814-018-0290-8.

Hariyanto, H., Denison, T. and Stillman, L. (2018) 'Understanding health information system implementation in an Indonesian primary health centre: A sociotechnical perspective', *Proceedings of the 22nd Pacific Asia Conference on Information Systems - Opportunities and Challenges for the Digitized Society: Are We Ready?, PACIS 2018* [Preprint], (October).

Harries, A.D. *et al.* (2015) 'Diabetes mellitus and tuberculosis: programmatic management issues', *The International Journal of Tuberculosis and Lung Disease*, 19(8), pp. 879–886. Available at: https://doi.org/10.5588/ijtld.15.0069.

Ibeneme, S. *et al.* (2020) 'Impact of information and communication technology diffusion on HIV and tuberculosis health outcomes among African health systems', *Informatics*, 7(2), pp. 1–10. Available at: https://doi.org/10.3390/informatics7020011.

Iribarren, S.J. *et al.* (2020) 'Converting and expanding mobile support tools for tuberculosis treatment support: Design recommendations from domain and design experts', *Journal of Biomedical Informatics*, 112(100066), pp. 1–7. Available at: https://doi.org/10.1016/j.yjbinx.2019.100066.

Jeyakumar, T. *et al.* (2021) 'An education framework for effective implementation of a health information system: Scoping review', *Journal of Medical Internet Research*, 23(2), pp. 1–17. Available at: https://doi.org/10.2196/24691.

Kaunda-Khangamwa, B.N. *et al.* (2018) 'The effect of mobile phone text message reminders on health workers' adherence to case management guidelines for malaria and other diseases in Malawi: Lessons from qualitative data from a cluster-randomized trial', *Malaria Journal*, 17(1), pp. 1–13. Available at: https://doi.org/10.1186/s12936-018-2629-2.

Kurniawati, A., Padmawati, R.S. and Mahendradhata, Y. (2019) 'Acceptability of mandatory tuberculosis notification among private practitioners in Yogyakarta, Indonesia', *BMC Research Notes*, 12(1), pp. 1–7. Available at: https://doi.org/10.1186/s13104-019-4581-9.

Leung, C.C. *et al.* (2017) 'Effects of diabetes mellitus on the clinical presentation and treatment response in tuberculosis', *Respirology*, 22(6), pp. 1225–1232. Available at: https://doi.org/10.1111/resp.13017.

Lin, Y. *et al.* (2015) 'Screening of patients with Diabetes Mellitus for Tuberculosis in Community Health Settings in China', *Tropical Medicine and International Health*, 20(8), pp. 1073–1080. Available at: https://doi.org/10.1111/tmi.12519.

Lin, Y. *et al.* (2019) *Management of Diabetes Mellitus-Tuberculosis: A Guide to the Essential Practice.* first edit. Edited by International Union Against Tuberculosis and Lung Disease (The Union) and World Diabetes Foundation. Paris, France.

Listiowati, E. *et al.* (2023) 'How to engage patients in achieving patient safety: A qualitative study from healthcare professionals' perspective', *Heliyon*, 9(2), p. e13447. Available at: https://doi.org/10.1016/j.heliyon.2023.e13447.

Lungu, P.S. *et al.* (2022) 'Undernotification and underreporting of tuberculosis in Zambia: a national data quality assessment', *BMC Health Services Research*, 22(1), pp. 1–12. Available at: https://doi.org/10.1186/s12913-022-08431-2.

Majumdar, A. *et al.* (2019) 'Tuberculosis-diabetes screening: how well are we doing? A mixed-methods study from North India', *Public Health Action*, 9(1), pp. 3–10. Available at: https://doi.org/10.5588/pha.18.0048.

Natsiavas, P. *et al.* (2018) 'Comprehensive user requirements engineering methodology for secure and interoperable health data exchange 08 Information and Computing

Sciences 0806 Information Systems', *BMC Medical Informatics and Decision Making*, 18(1), pp. 1–16. Available at: https://doi.org/10.1186/s12911-018-0664-0.

Nicholson, T. *et al.* (2017) *Report and Analysis Toward comprehensive global health care delivery : Addressing the double threat of tuberculosis and diabetes*.

Nugroho, H.S.W., Notobroto, H.B. and Rosyanti, L. (2021) 'Acceptance model of a mandatory health information system in Indonesia', *Healthcare Informatics Research*, 27(2), pp. 127–136. Available at: https://doi.org/10.4258/HIR.2021.27.2.127.

Nyirenda, J.L.Z. *et al.* (2022) 'Bidirectional screening and treatment outcomes of diabetes mellitus (DM) and Tuberculosis (TB) patients in hospitals with measures to integrate care of DM and TB and those without integration measures in Malawi', *BMC Infectious Diseases*, 22(1), pp. 1–12. Available at: https://doi.org/10.1186/s12879-021-07017-3.

Nyumba, T.O. *et al.* (2018) 'The use of focus group discussion methodology: Insights from two decades of application in conservation', *Methods in Ecology and Evolution*, 9(1), pp. 20–32. Available at: https://doi.org/10.1111/2041-210X.12860.

Pellison, F.C. *et al.* (2020) 'Data integration in the Brazilian public health system for tuberculosis: Use of the semantic web to establish interoperability', *JMIR Medical Informatics*, 8(7). Available at: https://doi.org/10.2196/17176.

Pereira, R. *et al.* (2017) 'Unified health database creation: 125 million brazilian cohort from information systems of hospital, outpatient, births, notifications and mortalities: IJPDS (2017) Issue 1, Vol 1:205 Proceedings of the IPDLN Conference (August 2016)', *International Journal of Population Data Science*, 1(1). Available at:

https://doi.org/10.23889/ijpds.v1i1.225.

Prakoso, D.A. *et al.* (2023) 'Acceptability and feasibility of tuberculosis-diabetes mellitus screening implementation in private primary care clinics in Yogyakarta, Indonesia: a qualitative study', *BMC Public Health*, 23(1), pp. 1–14. Available at: https://doi.org/10.1186/s12889-023-16840-z.

Prioleau, T. *et al.* (2023) 'DiaTrend: A dataset from advanced diabetes technology to enable development of novel analytic solutions', *Scientific Data*, 10(1), pp. 1–9. Available at: https://doi.org/10.1038/s41597-023-02469-5.

Pyo, J. *et al.* (2023) 'Qualitative Research in Healthcare: Necessity and Characteristics', *Journal of Preventive Medicine and Public Health*, 56(1), pp. 12–20. Available at: https://doi.org/10.3961/jpmph.22.451.

Ratnasari, Y. and Sjaaf, A.C. (2023) 'Evaluation of Tuberculosis Recording and Reporting Case System At Syarif Hidayatullah Hospital in 2020', *Jurnal Administrasi Rumah Sakit Indonesia*, 9(1), pp. 21–24. Available at: https://doi.org/10.7454/arsi.v9i1.4742.

Republic Indonesia Ministry of Health (2023) *Laporan Program Penanggulangan Tuberkulosis Tahun 2022*.

Republic Indonesia Ministry of Health (2020a) *Strategi Nasional Penanggulangan Tuberkulosis di Indonesia 2020-2024*.

Republic Indonesia Ministry of Health (2020b) 'The Republic of Indonesia Joint External Monitoring Mission for Tuberculosis', *Republic Indonesia Ministry of Health*, pp. 1–105.

Robbiati, C. *et al.* (2022) 'Improving TB Surveillance and Patients' Quality of Care Through Improved Data Collection in Angola: Development of an Electronic Medical Record System in Two Health Facilities of Luanda', *Frontiers in Public Health*, 10(March), pp. 1–8. Available at: https://doi.org/10.3389/fpubh.2022.745928.

Salifu, R.S. and Hlongwana, K.W. (2020) 'Barriers and facilitators to bidirectional screening of TB-DM in Ghana: Healthcare workers' perspectives', *PLoS ONE*, 15(7 July), pp. 1–12. Available at: https://doi.org/10.1371/journal.pone.0 235914.

Scheelbeek, P.F.D. *et al.* (2020) 'Improving the use of focus group discussions in low income settings', *BMC Medical Research Methodology*, 20(1), pp. 1–10. Available at: https://doi.org/10.1186/s12874-020-01168-8.

Setiyadi, N.A. and Setyowati, M. (2022) 'Needs Assessment for an Information System to Support a TB Control Program in Indonesia', *KnE Life Sciences*, 2022, pp. 863–871. Available at: https://doi.org/10.18502/kls.v7i2.1038 7.

Setyowati, M. *et al.* (2020) 'Development of Health Information System in TB Control Decision Support: Territoriality-Based Approach'. Available at: https://doi.org/10.4108/eai.22-7-2020.2300294.

Stop TB Partnership (2018) 'Stop TB Field Guide 9: Strengthening Information Systems and Linkages to Care'.

Surya, A. *et al.* (2017) 'Quality Tuberculosis Care in Indonesia: Using Patient Pathway Analysis to Optimize Public–Private Collaboration', *The Journal of Infectious Diseases*, 216(suppl_7), pp. S724–S732. Available at: https://doi.org/10.1093/infdis/jix379.

Tong, A., Sainsbury, P. and Craig, J. (2007) 'Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups', *International Journal for Quality in Health Care*, 19(6), pp. 349–357. Available at: https://doi.org/10.1093/intqhc/mzm04 2.

Vaz, C. *et al.* (2022) 'Formative acceptance of ingestible biosensors to measure adherence to TB medications', *BMC Infectious Diseases*, 22(1), pp. 1–11. Available at: https://doi.org/10.1186/s12879-022-07756-x.

de Vries, G. *et al.* (2021) 'Human reading versus computer-automated reading of chest radiographs in a tuberculosis screening programme in Romania', *European Respiratory Journal*, 58(2004628), pp. 1–4. Available at: https://doi.org/10.1183/13993003.046 28-2020.

Wang, M. *et al.* (2023) 'Clinical assistant decision-making model of tuberculosis based on electronic health records', *BioData Mining*, 16(1), pp. 1–23. Available at: https://doi.org/10.1186/s13040-023-00328-y.

WHO (2023) *Global Tuberculosis Report 2023*. (WHO).

Wijiseno, B., Arini, M. and Listiowati, E. (2023) 'Healthcare workers' acceptance of the integrated tuberculosis–COVID-19 screening in central Java Private Hospitals, Indonesia', *Journal of Taibah University Medical Sciences*, 18(6), pp. 1311–1320. Available at: https://doi.org/10.1016/j.jtumed.2023. 05.010.

Zheng, C., Hu, M. and Gao, F. (2017) 'Diabetes and pulmonary tuberculosis: a global overview with special focus on the situation in Asian countries with high TB-DM burden', *Global Health Action*, 10(1), pp. 1–11. Available at: https://doi.org/10.1080/16549716.201 6.1264702.

Zhou, D. *et al.* (2019) 'Under-reporting of TB cases and associated factors: A case study in China', *BMC Public Health*, 19(1), pp. 1–9. Available at: https://doi.org/10.1186/s12889-019-8009-1.

Zwama, G. *et al.* (2021) 'Health system influences on the implementation of tuberculosis infection prevention and control at health facilities in low-income and middle-income countries: A scoping review', *BMJ Global Health*, 6(5), pp. 1–13. Available at: https://doi.org/10.1136/bmjgh-2020-004735.