Evaluation of the National Tuberculosis Program and Tuberculosis Surveillance System, Jordan 2021

Yousef Khader[1] (iD), Moad J Al-Rahamneh[2] (iD), Sara Abu Khudair[2] (iD), Hiba Abaza[3], Ayah Al Shatnawi[3], Ibrahim Abuhmed[4], Ahmad Saleh Abu Rumman[5], Khaled Okkah[6], Suha Mohammed Alghoul[6], Ibrahim Falah Maia[6] and Srinath Satyanarayana[3]

Abstract

Objectives: Evaluate and determine the gaps in the National Tuberculosis Program and Tuberculosis Surveillance System in Jordan.

Methods: A concurrent embedded mixed quantitative/qualitative methods study was conducted to assess the National Tuberculosis Program and Tuberculosis Surveillance System in Jordan. A semi-structured questionnaire was developed based on the Updated CDC Guideline for Evaluating Public Health Surveillance System to collect necessary information from service providers and other stakeholders.

Results: The National Tuberculosis Program and Tuberculosis Surveillance System encounter various gaps and challenges across several critical domains, including infrastructure, human resources, National Tuberculosis Program functions, surveillance system performance, coordination, case findings, and data collection and notification. Regrettably, not all of the Tuberculosis Surveillance System's objectives were successfully achieved in the past. Coordination of tuberculosis services has been repeatedly reported as inadequate. This deficiency manifests in the delay in diagnosing tuberculosis patients and, in some instances, misdiagnoses. The root cause is often traced back to insufficient knowledge of tuberculosis case definitions among healthcare providers at peripheral tuberculosis clinics. Additionally, a structured approach to active case finding is conspicuously absent. Furthermore, the tuberculosis management guidelines remain unfamiliar to many healthcare providers in tuberculosis centers, leaving them inadequately equipped to handle tuberculosis cases effectively. The utilization and analysis of the system's data are also far from optimal. A glaring concern is the delay in tuberculosis case notifications received from the stakeholders involved in the Tuberculosis Surveillance System.

Conclusions: Our study showed different gaps in the National Tuberculosis Program and Tuberculosis Surveillance Systems across several areas. The structure of National Tuberculosis Program and the clinical expertise of human resources do not support tuberculosis elimination. An electronic data collection and notification system is essential to facilitate tuberculosis case detection, reporting, and follow-up. Decision-makers should push the tuberculosis epidemic on the national health agenda. Jordan should focus on allocating national and international resources for tuberculosis control programs.

[1]Department of Community Medicine, Public Health, and Family Medicine, Faculty of Medicine, Jordan University of Science and Technology, Irbid, Jordan
[2]Eastern Mediterranean Public Health Network, Amman, Jordan
[3]Migration Health Division, International Organization for Migration, Amman, Jordan
[4]Pulmonary Diseases and TB Directorate, Jordan Ministry of Health, Amman, Jordan
[5]Department of Chest Disease and Foreigners, Jordan Ministry of Health, Amman, Jordan
[6]Directorate of Chest Diseases and Migrant Health, Jordan Ministry of Health, Amman, Jordan

Corresponding author:
Yousef Khader, Department of Community Medicine, Public Health, and Family Medicine, Faculty of Medicine, Jordan University of Science & Technology, P.O. Box 3030, 22110, Irbid, Jordan
Email: yskhader@just.edu.jo

Introduction

Tuberculosis (TB) is one of the top 10 causes of death worldwide and the leading cause of death from a single infectious agent.[1] Despite notable progress in the past decade, TB remains a significant global public health issue with far-reaching health, economic, and social consequences. An estimated 10 million people (5.6 million men, 3.2 million women, and 1.2 million children) got infected with TB worldwide in 2019 and a total of 1.4 million people died from TB.[1,2] Globally, TB incidence is falling at about 2% per year. Between 2015 and 2019, the cumulative reduction was 9%.[1,2]

The estimated incidence of TB in Jordan has fluctuated over the last 10 years, peaking in 2017 at 7 cases per 100,000 population.[3] It then fell steadily, reaching a rate of 4 cases per 100,000 population in 2022.[3] A recent study[4] showed that the average annual crude TB notification rate in Jordan during 2016–2020 was 3.32 per 100,000 population (4.08 per 100,000 women and 2.64 per 100,000 men). The average annual standardized notification rate was 4.13 per 100,000 population (4.52 per 100,000 women and 3.52 per 100,000 men). During the period 2016–2020, a total of 1711 patients (989 women and 722 men) were diagnosed with and treated for TB. Of those, 14 cases were classified as relapses. Almost half of the patients (48.4%) were Jordanians and 51.6% were non-Jordanians. The majority of non-Jordanian patients were from Syria, the Philippines, and Bangladesh. Two-thirds of patients (66.0%) had pulmonary TB and 34.0% had extrapulmonary TB.

TB control in Jordan is a model for the region as it has the lowest TB prevalence compared with neighboring countries.[5] The Jordan National Tuberculosis Program (NTP) reached the Millennium Development Goal for TB reduction in 2011 and was preparing to shift to TB elimination. However, TB elimination planning has been disrupted due to the influx of Syrian refugees.[6] The establishment of effective NTPs and robust TB Surveillance Systems is vital in controlling the disease by early detection, prompt treatment, contact tracing, and monitoring drug resistance. Surveillance systems collect data on TB cases and treatment outcomes, allowing for the assessment of the TB burden, the effectiveness of interventions, and the identification of areas that require additional resources and attention. The data collected through surveillance systems help allocate resources effectively, ensuring that interventions are targeted where they are needed most. NTPs and surveillance systems support ongoing evaluation and quality improvement efforts to enhance the effectiveness of TB control programs.

The Jordan NTP is a national entity with the Chest Diseases and Migrant Health (CDMH) Directorate in Amman City at the central level and 12 peripheral chest centers throughout the country. The NTP was introduced in the mid-1990s. In 2017, the NTP adopted the End TB Strategy to initiate the process of TB elimination in Jordan in line with the World Health Organization (WHO) recommendations. TB Surveillance System in Jordan is one of the main functions of the NTP, and it is a passive, case-based surveillance system that depends on the definition of the case and recognition of illness, a compilation of individual data, analysis, and reporting.

The surveillance system in Jordan relies on multiple layers of reporting structure from the facility to the central level; therefore, the system must be well designed and implemented efficiently to prevent any delays in the release of data and substantial waste of human and time resources.[7] The managers of NTP in Jordan recognized the need for systematic program evaluation to monitor progress toward program goals, learn from both successes and mistakes, and judge the success of the program in achieving its short-term, intermediate, and long-term outcomes. NTP and TB Surveillance System in Jordan have never been evaluated systematically and comprehensively. Thus, this study aimed to determine the gaps in the NTP and the surveillance system and assess the usefulness and functionality of TB surveillance in terms of simplicity, flexibility, sensitivity, representativeness, timeliness, and stability.

Methods

Study design

A comprehensive evaluative study was undertaken to assess the effectiveness of Jordan's NTP and its TB Surveillance System during the period April 2021 to January 2022. This study employed a concurrent embedded mixed-methods approach, combining both quantitative and qualitative methods to provide a thorough evaluation.

Data sources

Various methodologies and data sources were harnessed for data collection in this study. Initially, a 2-day workshop was convened, bringing together seven key informants, stakeholders, and service providers associated with the CDMH Directorate at the central level, as well as the International Organization for Migration (IOM). The key informant inclusion criteria were specific to individuals who occupied pivotal positions in program management and the delivery of TB services, possessing substantial and profound insights into the provided services. However, two individuals were excluded from the study as they were newly hired within the NTP. The primary aim of the workshop was to elicit the perspectives of the participants regarding the NTP and the TB Surveillance System.

Participants were assured of the confidentiality and voluntary nature of their involvement, with the right to withdraw at any point. The workshop was held in a quiet room at the first investigator institution and skillfully moderated by a male experienced researcher (a professor of epidemiology and biostatistics (ScD) and the first author, who has 20 years of research experience) who employed a structured guide featuring open-ended questions to stimulate discussion and encourage participants to express their thoughts freely and

spontaneously. The second author took notes during the discussion with the participants. All participants willingly provided their informed consent, which included consent for the audio recording of the discussions. The saturation was not considered as we encompassed all individuals who played pivotal roles in both program management and the delivery of TB services.

Additionally, field visits were conducted to key organizations, including the CDMH Directorate, the Jordanian Anti-Tuberculosis Association (JATA), the IOM, and Annoor Sanitarium, with the purpose of conducting interviews with relevant personnel to ensure the comprehensive acquisition of necessary data. These visits entailed individual interviews with key stakeholders from the MoH Headquarters, the NTP, the CDMH Directorate, JATA, and IOM. The study also incorporated the examination of existing surveillance reports, records, forms, and patients' data as Supplemental Data Sources.

Assessment tools

A semi-structured questionnaire (Supplemental File 1) was developed based on the Updated CDC Guideline for Evaluating Public Health Surveillance System[8] and other relative resources.[9,10] To fortify the strength of the assessment tool strength and question consistency, we enlisted the expertise of three public health specialists. They conducted a comprehensive review of the tool, meticulously assessing its content validity. This involved a meticulous evaluation of the items to ensure relevance, clarity, and representativeness, and they offered valuable feedback. We diligently incorporated pertinent adjustments based on their insights. Collectively, the experts affirmed that the items sufficiently cover the required constructs, are culturally appropriate, identify gaps within the NTP and surveillance system, and are apt for evaluating the effectiveness and functionality of TB surveillance. Specifically, they deemed the items appropriate in assessing the simplicity, flexibility, sensitivity, representativeness, timeliness, and stability of the TB Surveillance System. The first part of the questionnaire included information about the participants' characteristics: gender, age, profession, specialty, job description related to TB, place of work, years of experience related to TB and surveillance, and training and certificates related to TB and surveillance. The questionnaire assessed issues concerning NTP, communication and reporting systems, availability of surveillance documentation, registers, reporting formats, data analysis and interpretation practices, computer skills and training profiles, epidemic response and preparedness situation, outbreak investigation and case confirmation, supervision and feedback system, the surveillance attributes (simplicity, flexibility, data quality, acceptability, sensitivity, predictive value positive, representativeness, timeliness, and stability), and ethical considerations and data security.

The assessment tool was divided into two main parts; (1) Assessment of the NTP, and (2) Assessment of the TB Surveillance System, which also was divided into two components; (a) Description of the surveillance system, and (b) Credible evidence regarding the performance of the surveillance system, as illustrated in Figure 1. For the description of the surveillance system, the tool collected information about the following components, stakeholders' engagement in the evaluation, description of the purpose and operation of the TB Surveillance System, description of the resources used to operate the TB Surveillance System, and TB data. To provide credible evidence regarding the performance of the surveillance system, the tool collected information on the following attributes:

1. *Level of usefulness*: Refers to the level of usefulness of information generated by the TB Surveillance System, and how the data can be used to improve public health in relation to TB in Jordan.
2. *Simplicity:* Intends to assess the TB Surveillance System structure and ease of operation.
3. *Flexibility:* To know if the TB Surveillance System can adapt to changing information needs or operating conditions with little additional time, personnel, or allocated funds.
4. *Data completeness:* Reflects the level of completed and missing data and the reasons and factors affecting the missing in the TB Surveillance System.
5. *Data validity:* To check the accuracy and quality of source data before using, importing, or otherwise processing data.
6. *Acceptability:* Reflects the willingness of persons and organizations to participate in the surveillance system.
7. *Stability:* Refers to the reliability (i.e., the ability to collect, manage, and provide data properly without failure) and availability (the ability to be operational when it is needed) of the public health surveillance system.

Ethical approval

The ethical approval was obtained from the Institutional Review Board (IRB) at the Ministry of Health on 30 March 2021 (the IRB Approval No. MoH/Rec/2021/056). Written informed consent was obtained from each participant. Participation remained anonymous and data were treated with confidentiality.

Data analysis

The current study employed directed content analysis, which involved the utilization of predetermined questions that guided the responses of participants during interviews. Directed content analysis was used in this study because researchers had specific research questions and a priori
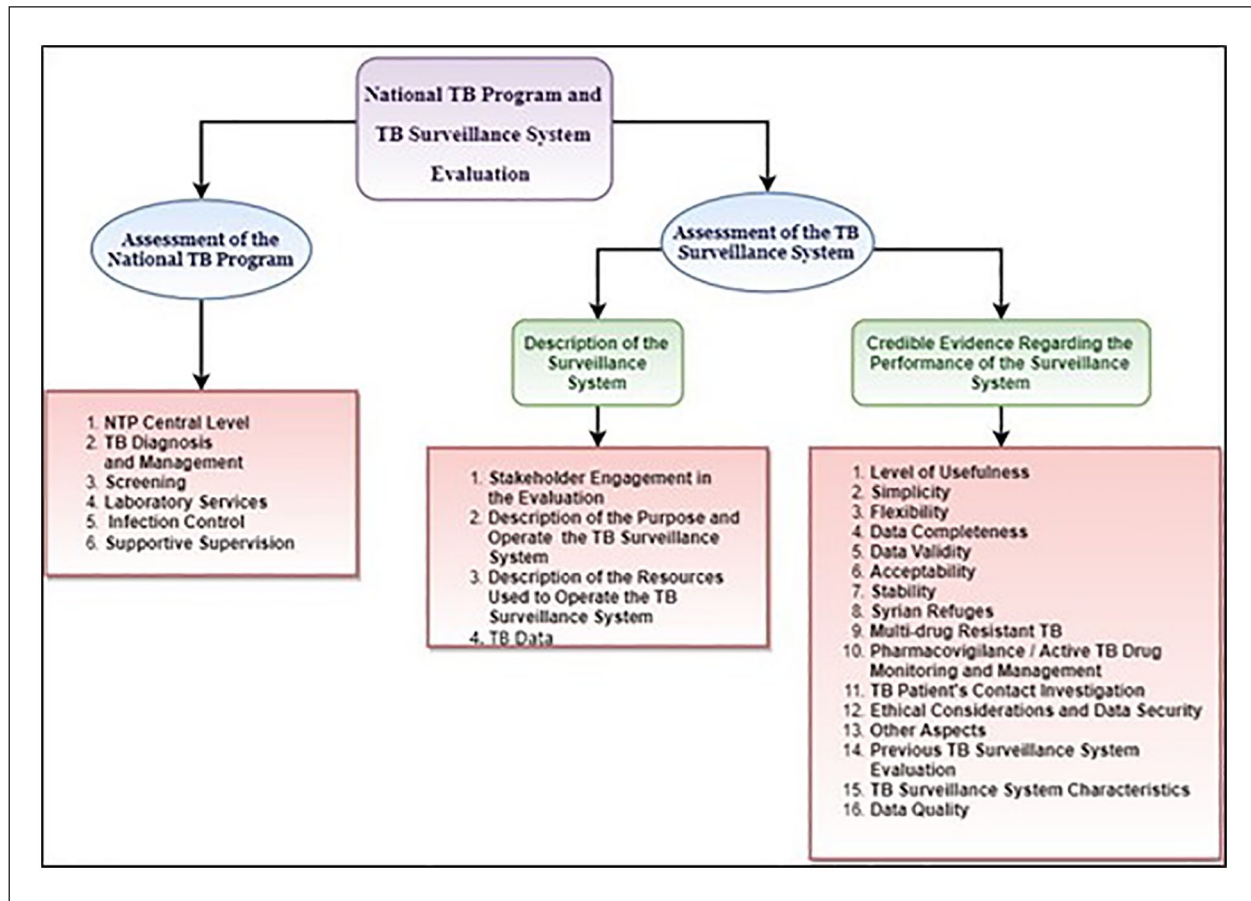
Figure 1. TB Surveillance System assessment tool flowchart.

knowledge about the NTP and TB Surveillance System. To maintain the trustworthiness and credibility of the findings, all discussions were faithfully transcribed in the Arabic language and subsequently translated into English. The interview questions served as a framework for data analysis. Researchers conducted the analysis in the original Arabic language manually. The process involved a manual examination of the transcribed data by two researchers, wherein meaning units were identified, followed by condensation of the data into meaningful patterns or summaries and coding, ultimately leading to the generation of distinct categories. We analyzed the patterns and themes that have emerged from the coding process. Then we presented the results of the directed content analysis in a clear and organized manner and used quotations to support findings. The report of findings was shared with the participants for their comments who all approved the findings listed in the report.

Results

Key informants' characteristics

A total of seven key informants from MoH and IOM (five males and two females) have participated in the evaluation. The key informants have different specialties and roles in the

NTP and TB Surveillance System and years of experience. Table 1 shows the key informants' characteristics.

Assessment of the NTP

The functions of the NTP and human resources

The primary functions of the NTP include the organization and delivery of TB care and prevention services. The NTP conducts a range of activities, including testing all migrants entering Jordan, treatment and follow-up of patients with TB, and screening for TB among contacts, refugees, prisoners, and at-risk populations. There was a broad consensus that one of the main gaps the NTP faces regarding human resources is the lack of a fixed (full-time) Pulmonologist at the CDMH Directorate.

Coordination of TB services

There is technical coordination between the NTP central level and TB clinics (NTP peripheral level). Many patients are usually transferred to the CDMH Directorate due to a lack of diagnosis and treatment capacities. However, the coordination between the NTP central level and Annoor Sanatorium is neither formal nor comprehensive. It only

Table 1. The key informants' characteristics.

Variable	n	%
Gender		
Male	5	71.4
Female	2	28.6
Age		
30–39	2	28.6
40–49	3	42.9
50–59	2	28.6
Profession		
Physician	4	57.1
Lab technician	1	14.3
Radiology technician	1	14.3
Nurse	1	14.3
Job description related to TB		
Medical officer—coordination with NTP	1	14.3
Head of laboratory	1	14.3
Data management	1	14.3
Head of TB physicians	1	14.3
Radiology technician	1	14.3
TB physician	1	14.3
TB case management	1	14.3
Years of experience working with TB and surveillance		
1–5	3	42.9
6–10	2	28.6
11–15	1	14.3
15–20	1	14.3
Training and certificates related to TB and surveillance	4	57.1

concerns the TB patients' referral, especially multidrug-resistant TB patients to Annoor Sanatorium. Annoor Sanatorium is the only facility in Jordan that is prepared and equipped to provide full care for TB patients. After the patient is transferred, no follow-up from the part of the CDMH Directorate is done for the transferred case. Regarding the NTP central level regular meetings, the members of the program have some meetings, but these meetings are not organized and structured, nor formal. Two respondents reported, "There is no regular base of the frequency of these meetings. They are upon need and availability."

TB diagnosis and detection

It has been stated that there is a delay in the diagnosis of TB patients and misdiagnosis in some cases due to inadequate TB healthcare providers' knowledge of TB case definition in peripheral TB clinics. One respondent mentioned, "These clinics lack the required capacities for TB diagnosis, making them transfer many cases to the CDMH Directorate to get tested." The role of the private sector in TB diagnosis is minimal.

Contact tracing

IOM facilitates contact tracing once the TB diagnosis is confirmed while the NTP conducts the TB investigations.

Respondents unanimously concurred that a significant deficiency in TB contact tracing lies in the absence of a dedicated database to capture information gleaned during contact tracing, coupled with the lack of a structured approach to active case finding. Consequently, the actual number of TB patients in Jordan remains largely concealed. Another critical gap is the considerable cost associated with TB tests for individuals who voluntarily seek testing and subsequently receive negative results.

TB management and treatment

The treatment is free for all TB patients in Jordan. Regarding TB treatment for migrants, all active TB patients are treated by transferring them to Annoor Sanitarium and Al-Basheer Hospital until they get negative results for TB, after which they are transferred to their countries. In case they have latent TB, they get transferred directly to their countries according to the law in Jordan without being registered in the NTP data. IOM is responsible for TB treatment for Syrian refugees in Jordan. IOM covers the cost of the treatment for out-patients, and Annoor Sanitarium does not charge any patient for any treatment and examinations. There are national guidelines for TB management in Jordan (Manual), including diagnosis and treatment. They are well written, printed, and available in Arabic. In addition, there is an algorithm (flowchart) explaining step-by-step for establishing TB diagnosis. Nevertheless, not all healthcare providers in TB centers are aware of or trained on these guidelines. Indeed, these guidelines were not seen in the majority of TB clinics during the field visits.

Patients' follow-up

In respect of TB patients' follow-up, the Directly Observed Treatment Strategy (DOTS) program was used for this purpose. Nevertheless, the program has stopped due to a lack of funds and support and the resulting stigma that the DOTS program causes to the patients. Consequently, it has been agreed to use a phone call to follow-up on the patient's situation and their commitment to the treatment.

Screening

Despite that TB disease is screened at the CDMH Directorate along with numerous diseases and health conditions, this service is performed only for migrants as an obligatory test for residency requirements. There is inadequate screening among key populations characterized by crowdedness, in particular, the prisons, camps, and migrant settlements. On the other hand, IOM is leading the TB screening among Syrian refugees.

Laboratory services

The main gaps in the laboratory at the central level include a shortage of lab personnel, not entering data in an appropriate

database, old computers, and inadequate documentation of patients' results. Moreover, data records are not connected with the TB patients' database which is managed by the NTP central level.

Infection control

There are some gaps regarding infection control at the CDMH Directorate. There is no infection control office/unit in the directorate. The infection control measures are not applied properly due to the poor conditions of the CDMH Directorate building. Moreover, the infection control measures are not assessed or monitored regularly.

Assessment of TB Surveillance System in Jordan

The purpose and operation of the TB Surveillance System

The TB Surveillance System faces challenges in terms of deficiencies in human resources, equipment, and training activities. The TB Surveillance System in Jordan is passive and targets Jordanians, refugees, and migrants in the country. The specific objectives for the TB Surveillance System are: (1) Early detection and containment of TB cases; (2) Determining priorities in planning to enhance health services; (3) Identifying people at high risk for TB exposure and infection, and identifying the various risk factors of TB, and assess its trend; and (4) Evaluating prevention and control measures and introducing the necessary modification according to TB epidemiology in the country. It has been observed that not all TB Surveillance System objectives were met in the past and that the system activities are not directed toward these objectives. In addition, the main TB healthcare providers and other stakeholders are not fully aware of the system's objectives.

Case definition

The field visits revealed that some of the TB clinic staff have no common understanding of the case definition of the TB disease, despite that it is documented in the national guideline for TB management in Jordan. According to the national guideline for TB management in Jordan, TB case definitions are divided into two groups; (1) Bacteriologically confirmed TB case: the biological specimen is positive, (2) Clinically diagnosed TB case: X-ray abnormalities or suggestive histopathology evidence and extrapulmonary cases without laboratory confirmation.

TB Surveillance System notification pathway

The TB Surveillance System is centered around the CDMH Directorate. There are several sources of data that feed the TB Surveillance System in Jordan, such as laboratories (public and private), hospitals (public and private), health centers, TB clinics, and private clinics. Some gaps related to TB notification and reporting were reported by the respondents and observed in the field visits including that the notification method is paper based and sent via fax, some of the notification reports are incomplete; there is no assigned focal point at the TB clinics to complete, review, and finalize the notification reports before submitting them to the CDMH Directorate. Moreover, the TB Surveillance System is not linked to the national health information system and vital registration system.

Data quality and analysis

The collected data are entered into an Excel sheet and include information on age, gender, referral site, governorate, TB center, nationality, sub-nationality, occupation, marital status, date of symptoms onset, type of patient site of TB, sub-diagnosis, HIV test result, X-ray result, sputum result, and treatment outcome. By checking the dataset, it has been observed that different registration date formats in Excel were used, making the function of date calculation in Excel difficult. Some data fields are updated by inserting comments on the Excel sheet, which goes unnoticed during analysis.

It has been stated and noted that there is no systematic and structured analysis of TB data. Some descriptive data analysis in the form of frequency distribution is usually performed by one of the CDMH staff using the Microsoft Excel Program. The performed analysis is not thorough nor advanced and does not check for outliers or data quality, and it is normally done quarterly or upon request from WHO or MoH. The data are entered using text format, and therefore, the data need to be coded and labeled for further analysis. On the other hand, no specialized statistical software is used to analyze the data, and none of the CDMH staff is trained in data management, analysis, and interpretation. TB surveillance data carry inherent limitations when it comes to scientific rigorousness, and TB notifications may not be considered a direct measure or close proxy of TB incidence.

The performance of the surveillance system

Level of usefulness

Stakeholders rated the level of usefulness of the data as not satisfactory. The data that the system provides are not well utilized or analyzed thoroughly. All respondents mentioned, "The complete information on TB in Jordan is not well presented and reflected in the TB reports." It has been mentioned that there is no set plan to use the generated data; the data are mainly used for reporting to the WHO upon their request. In addition, it has been reported that there were no

actions taken as a result of the analysis and interpretation of the generated data from the TB Surveillance System.

Simplicity

The amount and type of data necessary to establish the TB diagnosis are sufficient. The data for TB patients are easy to collect because the patient's file is well structured and clear to the healthcare providers. The time needed to collect the necessary data is almost 30 min. Following up on a case to update data is done for all cases. The key informants mentioned that there is no need to add more variables to the patient's file or the data on the Excel file.

Flexibility

Flexibility was rated good. Some variables and information have been modified and updated successfully. The patient's record file was updated recently, and the case definition has been modified in the new file, which supports the system's flexibility. However, these updates were not reflected in the Excel database.

Timeliness

The level of coordination with other reporting sites is intermediate as assessed by stakeholders. The information does not always reach on time. There is a delay in TB case notification received from the parties involved in the TB Surveillance System, because it may have reached via mail or fax after a month of sending.

Data completeness

According to the stakeholders, the percentage of missing values (data) ("unknown" or "blank") within a dataset is almost 10%. However, during the monthly update of the data, some missing data normally are recovered personally by contacting the data providers (peripheral TB clinics of patient's file). Usually, the missing data are the onset of symptoms and the outcome of the patients. On the other hand, the level of completeness in notification reports was rated intermediate. A few problems were noted such as missing data mainly from the peripheral TB clinics.

Acceptability

According to stakeholders, the data providers' participation rate in the system is moderate. Not all TB healthcare providers—especially at the peripheral TB clinics—participate in the data collection, notification, and reporting.

Ethical considerations and data security

Critical gaps were observed regarding the ethical issues for TB patients and their data; TB patients do not sign a consent form before giving the data, and in many cases, the patient does not know that they have to give their consent before obtaining the data from them. On the other hand, there is no written Standard Operating Procedure for the ethical considerations for the TB Surveillance System in Jordan, including patients' privacy and data security. The policies and procedures that ensure patient privacy and surveillance system security are not applied. There is no private or closed room where the patient gives their information; in addition, the data are not secured, and anyone who knows the computer password can get the data.

Discussion

This comprehensive study delineated the manifold gaps and challenges encountered by the NTP and TB Surveillance System in Jordan, spanning critical domains such as infrastructure, human resources, NTP functions, surveillance system efficacy, coordination, case identification, and data collection and notification. Most Eastern Mediterranean Region (EMR) countries have updated their national strategic plans and some countries with low disease burdens are actively aiming for TB elimination.[11] An editorial underscored a significant challenge impeding the region's efforts to eliminate TB, citing suboptimal political commitment, low case detection rates, and the overarching impact of humanitarian emergencies.[12]

This study identified several gaps in the NTP and TB Surveillance System in Jordan. One of the main challenges is that patients/visitors face difficulty in reaching and accessing TB services. The lack of access to TB services was reported by the global WHO TB report and other studies as a significant barrier to effective TB control programs worldwide.[13,14] Lack of access to TB health centers promotes ongoing TB transmission within the community.[15] Effective TB management requires a well-designed, equipped, and well-located health facility that ensures a safe environment for both patients and employees. Therefore, the Jordan government needs to secure funds to construct a new building commensurate with health standards for TB and patients/visitors' needs and to be conveniently located.

There was a broad consensus that one of the main gaps in the NTP is the lack of a pulmonologist at the CDMH Directorate. This finding is consistent with findings from other studies conducted in various settings.[16,17] The lack of a fixed pulmonologist can have detrimental effects on the delivery of TB care and prevention services, leading to diagnostic delays, treatment challenges, and compromised patient outcomes.[17,18] Efficient TB management and control need well-qualified healthcare providers in technical and managerial aspects. MoH has to take the lead in providing TB specialists, promoting and motivating healthcare providers to work in TB facilities through compensation or incentives, and implementing TB training programs.

The study identified that the coordination of TB services needs strengthening. Poor coordination between the CDMH

Directorate and the Colunatary Counseling and Testing (VCT) Center can have several significant consequences, particularly delayed diagnosis and treatment, and increased transmission risk. This finding is in agreement with the findings of other assessments in other countries that identified gaps in service delivery, duplication of efforts, and inefficiencies in resource allocation as contributing factors to poor coordination.[19,20] Poor coordination can result in missed or late diagnoses, which can lead to disease progression and increased transmission of TB and HIV/AIDS, posing a public health risk. A coordination plan must be set between the central level and other parties involved in the TB Surveillance System in Jordan, and this coordination must be formal, systematic, continuous, and dynamic.

There is a national guideline for TB management in Jordan including diagnosis and treatment. Yet, not all healthcare providers in TB centers are aware or trained on these guidelines. A recent study (unpublished) of 93 Jordanian health care workers (HCWs) who were involved in TB diagnosis, management, or prevention (22 physicians, 27 nurses, and 44 other HCWs such as pharmacists and technicians) showed that 38.7% of HCWs had not received any training on TB and 14% of them had received training in more than 2 years. The majority of HCWs (94.6%) perceived that they need more training on TB. Private sector healthcare professionals in Jordan did not receive adequate training in TB diagnosis and management and they are not familiar with the latest diagnostic techniques and guidelines, leading to suboptimal care. Training the TB healthcare providers on different aspects of TB including the TB management guidelines is recommended to standardize and enhance TB case management among all NTP central and peripheral levels.[21]

The early detection and timely treatment of patients with TB are essential for effective TB control and are emphasized in the "End TB Strategy" of the WHO.[22,23] Delays occurring during the process of diagnosis and treatment increase the probability of TB transmission and eventually result in a higher disease burden.[24] TB case definition needs to be well understood by healthcare providers in the TB healthcare centers in Jordan through providing general training on TB and well-designed and printed posters and brochures on TB.

The NTP has no structured active case finding and screening key populations. Crowded communities such as prisons and camps were reported to be associated with an increased risk of TB incidence.[25–27] Crowding may directly favor TB transmission by increasing the contact rate between *Mycobacterium tuberculosis* and susceptible people.[28–30] Without active case finding and screening, TB cases may go undetected until patients become symptomatic and seek medical care. Therefore, a structured active case finding and screening program is crucial for uncovering the hidden burden of TB in the community.

The laboratory is a cornerstone of any surveillance system. It plays a critical role in the prompt diagnosis of diseases and treatment monitoring. With the challenges that the laboratory is encountering, a series of actions have to be taken to enhance the function of the laboratory and raise the quality of the results. The communication channels between doctors and the laboratory staff need to be enhanced, as well as the laboratory database has to be connected with the patients' database that is managed by the NTP central.

Despite that the TB Surveillance System is funded, it still faces challenges in terms of deficiencies in human resources, equipment, and training. Healthcare resources are often stretched thin due to a variety of competing health priorities. Government budgets are allocated to address pressing issues such as infectious disease outbreaks leaving limited funds available for TB control. Echoing these findings, a situational analysis of TB control programs in the EMR[31] revealed similar deficiencies, encompassing limited infrastructure, human capacity constraints, financial shortages, underutilization of advanced diagnostic tools and medications, as well as inadequate stakeholder and community involvement in TB care amidst complex emergencies. Furthermore, another study highlighted recurring gaps in TB care across multiple EMR countries, primarily linked to restricted access to essential resources.[32] Collaborative efforts involving government agencies, non-governmental organizations, international partners, and civil society can help mobilize resources and support for TB prevention, surveillance, diagnosis, and treatment in the country.

In this evaluation, it has been stated that not all TB Surveillance System objectives were met. The seven key informants from MoH and IOM reported that "we are not aware that the system data were used in the past to determine priorities, identify those at risk, determine TB risk factors, and evaluate prevention and control measures." To achieve the TB Surveillance System objectives, a systematic, comprehensive, and innovative system and action plan must be established and implemented. The objectives should be linked with specific targets, indicators, and outcomes. The TB Surveillance System faces notable gaps and issues regarding data quality and analysis. This finding is consistent with the findings of other studies[33,34] but inconsistent with the findings of other studies.[35,36] Without meaningful data to inform public health action, Jordan is likely to fall short of its goal of eliminating TB.

Regarding the system attributes, the TB Surveillance System is simple with sufficient amount and type of data necessary to establish the TB diagnosis; however, some information can be added to the system, such as social indicators, and if the TB is confirmed bacteriologically or clinically. In other countries, some studies reported poor ratings of the simplicity of the system for several reasons including data collection is time-consuming and report forms are not easy to fill.[3,34,37] However, other studies in Yemen, Pakistan, and South Africa[35,39,40] reported that the system is simple. On the other hand, flexibility was rated good with some updates that need to be reflected in the dataset. In other studies, in Pakistan and Zimbabwe, flexibility was rated "average."[38,40]

One primary limitation of this study lies in the restricted number of key informants, potentially introducing bias in identifying gaps within Jordan's NTP and TB Surveillance System. Nonetheless, the utilization of diverse methodologies and data sources in this study is anticipated to mitigate this challenge. Another significant limitation of this study arises from the scarcity of high-quality data within the NTP, which hinders the ability to thoroughly analyze and substantiate the study's findings. Additionally, the study is impeded by inadequate documentation of NTP activities, encompassing data reports and program operations. While it is worth noting that the assessment tool underwent review by three public health professionals, one notable constraint is the absence of a pilot test, primarily due to the limited pool of eligible individuals available to participate in the assessment.

Conclusions

Our study showed different gaps in the NTP and TB Surveillance System across several areas, including infrastructure, human resources, the functioning and performance of the surveillance system, operational framework, coordination, and information and education. The structure of the NTP and the clinical expertise of human resources is not supportive of TB elimination. Elimination of TB in Jordan requires multiple interventions and preparations. Although the likelihood of TB emerging as an epidemic in the near future is low, the government should consider TB as a national threat. Decision-makers should place the TB epidemic on the national health agenda and spend time and effort to allocate national and international resources for TB control programs. The national health policies lack the intersectoral vision in facing health issues, which appears to be responsible for the limited attention to the importance of potent surveillance systems that are the only producers of reliable evidence necessary for policy decision-making. In addition, the lack of an intersectoral approach is responsible for the limited TB prevention programs and social interventions as compared with the concentrated treatment-oriented actions. The national efforts should continue to build and strengthen the national TB Surveillance System and build staff capacities. The MoH should be urged to report and publish regularly with standardized forms on the necessary TB information and data at the national and international levels. There is a need to work on identifying the high-risk and vulnerable groups and the best means to reach them not only for surveillance purposes but also for service provision. High-risk groups and other vulnerable groups in Jordan, including refugees and migrants, need tailored preventive programs to reduce risk behaviors in addition to healthcare and social support. The MoH should implement an effective strategy so that all health facilities and laboratories that perform tests notify positive cases. A full-time surveillance team should be formed to manage and oversee the development, implementation, coordination, improvement, and use of the resulting information and data. This team would then also be responsible for periodic quality assurance and monitoring site visits to ensure that the information is being collected according to the pre-established protocols.

Author contributions

YK and MA conceived the presented idea and supervised the implementation and results of this work. The other authors contributed to the review, writing, and editing of the final version of the manuscript. All authors read and approved the final manuscript.

Data availability

Data is available from the corresponding author upon reasonable request.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics approval and consent to participate

The ethical approval was obtained from the Institutional Review Board (IRB) at the Ministry of Health on March 30, 2021 (the IRB approval No. MoH/Rec/2021/056). All participants voluntarily signed an informed consent form, which included the consent to audiotape the discussion.

Informed consent

Written informed consent was obtained from all subjects before the study.

ORCID iDs

Yousef Khader https://orcid.org/0000-0002-7830-6857
Moad J. Al-Rahamneh https://orcid.org/0000-0001-6920-6523
Sara Abu Khudair https://orcid.org/0000-0002-6172-6898

Supplemental material

Supplemental material for this article is available online.

References

1. World Health Organization. Global tuberculosis report 2020, https://apps.who.int/iris/bitstream/handle/10665/336069/9789240013131-eng.pdf (2020, accessed 11 June 2023).

2. Chakaya J, Khan M, Ntoumi F, et al. Global tuberculosis report 2020—Reflections on the Global TB burden, treatment and prevention efforts. *Int J Infect Dis* 2021; 113(Suppl. 1): S7–S12.

3. The World Bank. Incidence of tuberculosis (per 100,000 people)—Jordan, https://data.worldbank.org/indicator/SH.TBS.INCD?locations=JO (2022, accessed 8 January 2024).

4. Khader Y, Abaza H, Satyanarayana S, et al. Tuberculosis notification in Jordan, 2016–2020. *Epidemiologia (Basel, Switzerland)* 2023; 4: 276–285.

5. World Health Organization. Global tuberculosis report 2012, https://iris.who.int/bitstream/handle/10665/75938/9789241564502_eng.pdf?sequence=1 (2012, accessed 11 June 2023).

6. Cookson ST, Abaza H, Clarke KR, et al. Impact of and response to increased tuberculosis prevalence among Syrian refugees compared with Jordanian tuberculosis prevalence: case study of a tuberculosis public health strategy. *Confl Health* 2015; 9: 1–7.

7. Bernstein AB, Sweeney MH and Centers for Disease Control and Prevention. Public health surveillance data: legal, policy, ethical, regulatory, and practical issues. *MMWR Suppl* 2012; 61: 30–34.

8. German RR, Lee LM, Horan JM, et al. Updated guidelines for evaluating public health surveillance systems: recommendations from the Guidelines Working Group. *MMWR Recomm Rep* 2001; 50: 1–35; quiz CE1–7.

9. Centers for Disease Control (CDC). Guidelines for evaluating surveillance systems. *MMWR Suppl* 1998; 37: 1–18.

10. Betley E, Sigouin A, Sterling EJ, et al. Stakeholder engagement in biodiversity programming. U.S. Agency for International Development, https://pdf.usaid.gov/pdf_docs/PA00T9XH.pdf (2018, accessed 12 June 2023).

11. World Health Organization. Global tuberculosis report 2016, https://www.who.int/publications/i/item/9789241565394 (accessed 7 January 2024).

12. Aziz MA, Baghdadi S and Hajjeh R. What would it take to eliminate tuberculosis in the Eastern Mediterranean Region? (Editorial). *East Mediterr Health J* 2017; 23(6): 393–394.

13. World Health Organization. *Global tuberculosis report 2023*, https://iris.who.int/bitstream/handle/10665/373828/9789240083851-eng.pdf?sequence=1 (2023, accessed 10 February 2024).

14. Asres M, Gedefaw M, Kahsay A, et al. Patients' delay in seeking health care for tuberculosis diagnosis in East Gojjam Zone, Northwest Ethiopia. *Am J Trop Med Hyg* 2017; 96: 1071.

15. An J, Gao M, Chu N, et al. Transregional movement of multidrug-resistant tuberculosis in north China: an underlying threat to tuberculosis control. *Sci Rep* 2016; 6: 29727.

16. Subbaraman R, Nathavitharana RR, Satyanarayana S, et al. The tuberculosis cascade of care in India's public sector: a systematic review and meta-analysis. *PLoS Med* 2016; 13: e1002149.

17. Regan WP. The responsibility of the physician in tuberculosis control. *J Ark Med Soc* 1964; 61: 228.

18. Ramos JP, Vieira M, Pimentel C, et al. Building bridges: multidisciplinary teams in tuberculosis prevention and care. *Breathe*; 19: 230092.

19. Atun R, Weil DE, Eang MT, et al. Health-system strengthening and tuberculosis control. *Lancet* 2010; 375: 2169–2178.

20. Curatio International Foundation. *Integrating tuberculosis services in primary health care*, https://curatiofoundation.org/wp-content/uploads/2017/08/Evidence-Summary_TB-in-PHC_02.08.2017_ENG.pdf (2017, accessed 11 February 2024).

21. Rodger A, Jaffar S, Paynter S, et al. Delay in the diagnosis of pulmonary tuberculosis, London, 1998–2000: analysis of surveillance data. *Br Med J* 2003; 326: 909.

22. World Health Organization and Regional Office for the Western Pacific. Tuberculosis control in migrant populations: guiding principles and proposed actions, https://apps.who.int/iris/bitstream/handle/10665/246423/9789290617754-eng.pdf?sequence=1&isAllowed=y (2016, accessed 12 June 2023).

23. World Health Organization. Implementing the End TB Strategy: the essentials, https://www.who.int/publications/i/item/implementing-the-end-tb-strategy (2015, accessed 12 June 2023).

24. Zhou C, Tobe RG, Chu J, et al. Detection delay of pulmonary tuberculosis patients among migrants in China: a cross-sectional study. *Int J Tuberc Lung Dis* 2012; 16: 1630–1636.

25. Harries AD, Zachariah R, Corbett EL, et al. The HIV-associated tuberculosis epidemic—when will we act? *Lancet* 2010; 375: 1906–1919.

26. Molina Serpa I, López Pardo C and Alonso Hernández R. Un estudio ecológico sobre tuberculosis en un municipio de Cuba. *Cad Saude Publica* 2003; 19: 1305–1312.

27. Myers WP, Westenhouse JL, Flood J, et al. An ecological study of tuberculosis transmission in California. *Am J Public Health* 2006; 96: 685–690.

28. Lienhardt C, Fielding K, Sillah JS, et al. Investigation of the risk factors for tuberculosis: a case–control study in three countries in West Africa. *Int J Epidemiol* 2005; 34: 914–923.

29. Shetty P. Health care for urban poor falls through the gap. *Lancet* 2011; 377: 627–628.

30. Dhanaraj B, Papanna MK, Adinarayanan S, et al. Prevalence and risk factors for adult pulmonary tuberculosis in a metropolitan city of South India. *PLoS One* 2015; 10: e0124260.

31. Baghdadi S. Situational analysis of tuberculosis control programs in the Eastern Mediterranean Region: gaps and solutions. *Int J Mycobacteriol* 2016; 5(Suppl. 1): S14.

32. Hasan R, Shakoor S, Baghdadi S, et al. Collaboration between tuberculosis control programs and the action plan for tackling antimicrobial resistance: an opportunity in the Eastern Mediterranean Region. *Int J Mycobacteriol* 2016; 5(Suppl. 1): S13.

33. Matambo R, Duri C, Ruhanya V, et al. Evaluation of a tuberculosis surveillance system in the Harare City Health Department in Zimbabwe. *Int J Trop Dis Health* 2016; 14: 1–10.

34. Al kalali FSA, Mahyoub E, Al-Hammadi A, et al. Evaluation of the national tuberculosis surveillance system in Sana'a, Yemen, 2018: observational study. *JMIR Public Health Surveill* 2021; 7: e27626.

35. Mlotshwa M, Smit S, Williams S, et al. Evaluating the electronic tuberculosis register surveillance system in Eden District, Western Cape, South Africa, 2015. *Glob Health Action* 2017; 10: 1360560.

36. Podewils LJ, Bantubani N, Bristow C, et al. Completeness and reliability of the Republic of South Africa national

tuberculosis (TB) surveillance system. *BMC Public Health* 2015; 15: 765.

37. Saeed KM, Bano R and Asghar RJ. Evaluation of the national tuberculosis surveillance system in Afghanistan. *East Mediterr Health J* 2013; 19: 200–207.

38. Makurumidze R, Gombe N, Bangure D, et al. Evaluation of the Tuberculosis Surveillance System in Shamva District, Zimbabwe, 2014. *J US-China Med Sci* 2017; 14: 64–71.

39. Abdulmughni J, Mahyoub EM, Alaghbari AT, et al. Performance of multidrug-resistant tuberculosis surveillance in Yemen: interview study. *JMIR Public Health Surveill*; 5: e14294.

40. Asif M, Amir Baig M, Nadeem Shah M, et al. Evaluation of the tuberculosis surveillance system in district Hyderabad, province Sindh-Pakistan, 2012. *Int J Trop Dis Health* 2015; 9: 1–8.