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Facilitators and barriers to implementing chest radiography in tuberculosis systematic screening of clinically high-risk groups in Ethiopia: A qualitative study

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Abstract

Background: Chest X-ray has been included in national tuberculosis screening algorithms as a sensitive tuberculosis screening tool among high-risk groups. However, the implementation was influenced by multiple factors. We aimed to explore facilitators and barriers to implementing chest X-ray in systematic tuberculosis screening of clinically high-risk groups in Addis Ababa, Ethiopia.

Methods: We conducted face-to-face, in-depth interviews with purposively selected participants at tertiary-level hospitals and a tuberculosis program coordinator at the Ethiopian Ministry of Health, who coordinates chest X-ray-guided systematic tuberculosis screening. A framework analysis was conducted using the consolidated framework for implementation research.

Results: We identified 11 constructs that influenced the implementation of the chest X-ray intervention. Facilitators included the relative sensitivity of chest X-ray over symptom-based screening, its potential integration into existing systems, technological advancements in the area, policies and laws supporting the screening intervention, and the quality of the evidence of the screening intervention. Barriers included implementation complexity, high costs of the intervention, knowledge gaps among healthcare providers, training gaps, low priority for chest X-ray screening at the healthcare facility level, and a lack of external support from the Ministry of Health and stakeholders.

Conclusion: This study identified contextual factors that influence the implementation of chest X-ray guided systematic tuberculosis screening among clinically high-risk groups that healthcare facilities and health ministries may use for decision-making. Addressing the barriers identified by the study would help to improve the implementation of chest X-rays for improved tuberculosis case detection and prompt treatment in clinically high-risk groups.

Keywords

Chest X-ray, tuberculosis, high-risk groups, systematic screening, Ethiopia

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Introduction

Tuberculosis (TB) remains the leading cause of death from a single infectious agent. According to the 2022 World Health Organization (WHO) Global TB Report, 1.6 million people have died of TB, and 2.9 million are missed to be diagnosed or enrolled in care.[1] Cases are missed largely due to limited access to healthcare services and the workforce and underdeveloped health reporting referral linkage systems.[2] Missing cases continue to circulate in the general population with a higher risk of spread of the disease.[3] Ethiopia is one of the 30 nations with a high TB burden, with an annual incidence of 140/100,000 and a death rate of 19 per 100,000 population.[4] It is estimated that 29% (48,000) of incident TB cases and 59% (816) of rifampicin resistance or multidrug-resistant tuberculosis (RR/MDR-TB) cases were missed nationally in 2020, but there was regional variation among missed cases in the community.[4,5] Suboptimal implementation of sensitive screening and testing tools such as chest X-ray and Xpert mycobacterium tuberculosis or rifampicin (MTB/RIF) assay, use of passive case-finding strategies, poor referral systems, and knowledge and attitude of the providers contribute to missing cases in Ethiopia.[6]

The risk of developing TB is high among clinically high-risk groups compared to the general population.[7,8] One of the pillars of the "End TB Strategy 2016–2035" is the systematic screening of people who are at high risk for TB.[9] The goal of screening is to identify patients as soon as possible to reduce unnecessary delays in diagnosis and treatment, which lowers the risk of poor treatment outcomes, health sequelae, and negative social and economic effects of TB for affected individuals and their families.[9] Targeted systematic screening programs and more sensitive and specific diagnostic tools can offer valuable diagnostic and treatment services, particularly to vulnerable populations with little access to care.[10,11]

Ethiopia adopted systematic TB screening algorithms in 2021, in line with the WHO consolidated screening guidelines. The algorithms recommend the use of chest X-ray as an initial screening tool, in addition to symptom screening, particularly for high-risk groups.[4] Chest X-rays have been used for TB screening for many years, together with the symptom complex of the disease in high-prevalence populations. Chest X-ray TB screening among asymptomatic high-risk individuals provides high yields, including persons living with human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), smokers, end-stage renal failure, drug or alcohol users, diabetes, prisoners, and close contacts with TB patients.[12] A study done in Uganda reported chest X-ray screening for pulmonary TB had 93% sensitivity and 65% specificity, which were higher than the 76% and 31%, respectively, found in symptom screening.[13] The yield of TB diagnosis increased by 38% as a result of screening methodologies that included chest X-rays in addition to symptoms. In Ethiopia, people diagnosed with TB with mild or no symptoms of TB have a better outcome from screening based on chest radiography.[14–16] When chest X-ray TB screening was used in the country's first national population-based TB prevalence survey, more than 50% of confirmed TB cases were identified using chest X-ray screening.[17] A facility-based cross-sectional study conducted in Ethiopia on the impact of early chest radiography on delay in pulmonary TB case notification showed that early screening using chest X-ray minimized delays in the diagnosis of pulmonary TB among people with coughs of any duration.[18]

The implementation of systematic screening of TB in high-burden countries is influenced by multiple factors, including low screening and testing capacity, limited understanding of systematic screening techniques, and limited health workers' competence in TB screening.[19–24] The characteristics of technological innovations and advancements, access, sensitivity, and specificity of chest X-ray techniques facilitate, while cost and providers' lack of technical competency hinder, the adoption of chest X-rays in systematic TB screening.[25–29]

Despite systematic screening interventions having been endorsed by the Ministry of Health and implemented in Ethiopia, the use of chest X-rays as screening tools among clinically high-risk groups in health facilities has not been adopted. Studies have not yet been conducted in Ethiopia to learn from clinicians about the facilitators and barriers to its implementation and the best ways to address identified challenges. Hence, this study aimed to explore facilitators and barriers to implementing chest X-rays in systematic TB screening of clinically high-risk groups in Addis Ababa, Ethiopia.

Methods

Study design

We used a qualitative study design using a qualitative content analysis approach. A consolidated framework for implementation research (CFIR) was used to understand the common factors that affect the implementation of the intervention in a given context, comprising five domains: innovation, outer, inner, individual, and implementation process domains.[30]

Study setting

The study was conducted in Addis Ababa, the capital city of Ethiopia. The Addis Ababa Health Bureau is responsible for overall health-related interventions in the city, including the administration of six government-owned hospitals and 106 health centers, while some other hospitals in the city are governed centrally by the Ministry of Health.[31] For this study, three tertiary-level government hospitals were included: St. Peter Hospital, Zewditu Memorial Hospital, and Yekatit 12 Hospital Medical College. St. Peter Specialized Hospital is under the jurisdiction of the Ministry of Health and is the leading TB-specialized hospital in Ethiopia. Zewditu

Memorial Hospital and Yekatit 12 Hospital Medical College are under the Addis Ababa Health Bureau, with higher TB and HIV patient loads. Hence, the three healthcare facilities were purposively selected for their active engagement and implementation of systematic TB screening. To further understand and triangulate the clinical and programmatic aspects of the implementation of the chest X-ray intervention, the Ethiopian Ministry of Health was also included in the study.

Participants

Criterion-based purposive sampling was used to select study participants. In each of the three hospitals, the criteria included having ample experience in healthcare services and working for more than a year in One-Stop Shops/Cough Outpatient Departments (OPDs), ART clinics, and regular OPDs. Participants who were unwilling to give consent or absent during the data collection session were excluded from the study. Based on the criteria, we have selected a total of 10 participants from three tertiary-level government hospitals. Of the total 10 participants, 9 were clinicians from the 3 hospitals, and the remaining participant was Tuberculosis and Leprosy coordinator at the Ministry of Health. The inclusion of the participant from the Ministry of Health was to obtain an in-depth understanding of the coordination at the national level. The principle of data saturation determined the sample size.[32] Since there was no new information that emerged, we stopped the interview at the proposed sample size.

Data collection

Data were collected using face-to-face in-depth interview techniques, which were conducted between 1 January and 31 March 2023. An interview guide was developed based on the CFIR construct. Interviews were conducted by the corresponding author, a medical doctor, with a master's degree in public health. He has good experience in qualitative research and conducting interviews. The interviewer was not involved in participant selection, and attachment to the participants was only for study purposes. The interview guide was not validated but rather piloted among two clinicians (20%) who were not on the list of study participants and the interview guide was refined as necessary. Participants were approached during their break at work and after work at their convenience. The purpose of the study was explained, and written informed consent was obtained before the interviews were conducted. Of the participants approached, five refused to be involved in the study due to lack of time. None of the participants dropped out of the study after initial acceptance, and repeat interviews were not conducted. Audio recordings were used to collect data during the interviews, and additional notes were taken during the interviews. The interviews were carried out within the health facilities in private locations and based on each participant's preference for the location and time. Each interview lasted an average of 25–30 min. All the interviews were audio recorded and transcribed verbatim into Amharic and then translated into English.

Data management and analysis

Deductive analysis was used based on the CFIR framework. Open code software was used to facilitate data management, coding, and analysis. The analysis was initiated after the data were transcribed and translated. The corresponding author who conducted the interview did the initial data analysis, which was checked and verified by the Investigator team. Stepwise, first, multiple revisions of the transcript and tape recordings were made to familiarize with the data. Second, coding using the CFIR domains and new emerging codes were looked at during line-by-line coding. Third, a code report was generated from Open Code Software 4.2. Fourth, the research team over checked the coding process. Fifth, analytical summaries were developed based on the construct. Finally, determinations were made whether the construct exerted a negative, positive, or neutral influence on the implementation of chest X-ray as a systematic TB screening tool among clinically high-risk groups.

Quality assurance

The trustworthiness of the data was ensured by applying different approaches following Lincoln and Guba's[33] four criteria, namely, credibility, dependability, confirmability, and transferability. Rapport and trust with informants were created to ensure prolonged engagement and persistent observation. The Consolidated Criteria for Reporting Qualitative Research checklist[34] was followed and applied throughout the data collection and analysis. Data collection from both the facility and ministerial level ensured data triangulation by person and place.

Ethical considerations

The study protocol has been reviewed and approved by the Research Ethical Review Committee of the Addis Continental Institute of Public Health (Reference No. ACIPH-MPH/063/15). Further permission to conduct the study was obtained from the Addis Ababa Health Bureau, the Ministry of Health, and each of the three study hospitals. Written informed consent was obtained from each participant after the provision of necessary explanations about the purpose, procedure, benefits, and risks of the study. Participants were informed of the voluntary participation and the right to refuse a few or all of the questions at any point. The privacy of the study participants was strictly maintained, and all the audio records were stored on a password-protected computer and

Table 1. Sociodemographic characteristics of the study participants from the Ministry of Health and tertiary hospitals, Addis Ababa, Ethiopia 2023 ($n = 10$).

ID	Age	Sex	Educational level	Department	Work experience (Year)
005	33	F	MD	OPD	5
006	49	F	MD	ART clinic	18
007	29	F	MD	ART clinic	2
008	32	M	MD	ART clinic	1
009	31	M	MD	One stop shop	5
010	26	F	MD	OPD	2
011	45	M	MD	TBL coordinator	3
012	36	M	MD, specialty in internal medicine	OPD	10
013	47	M	MD, specialty in internal medicine	OPD	17
014	36	M	MD, specialty in internal medicine	OPD	7

ID: participant identification; MD: medical doctor; OPD: outpatient department; ART: antiretroviral treatment; TBL: tuberculosis and leprosy.

Table 2. Facilitators and barriers to implementing chest X-ray for systematic TB screening among high-risk groups in tertiary hospitals in Addis Ababa across the four domains of the CFIR, 2023.

Domain	Themes	
	Facilitators	Barriers
Innovation	Advantage of the chest X-ray over symptom screening	Complexity implementing chest X-ray as a screening tool
	Quality of evidence of the intervention	High cost incurred by healthcare facilities
Outer	Policies and laws supporting the intervention	Lack of external support from the Ministry of Health and stakeholders
Inner	Availability of digital X-ray and technological advancements	Lack of access to training on updated guidelines and recommendations
	Supportive implementation systems already in place	Lack of priority for chest X-ray tool for TB screening at health facility
Individuals		Lack of uniform and comprehensive knowledge

deleted after proper transcription and translation to assure the confidentiality of the information obtained.

Results

A total of 10 in-depth interviews were conducted. The characteristics of the participants are described in Table 1.

Eleven constructs across the four domains of the CFIR model emerged as important factors influencing positively or negatively the implementation of chest X-ray in systematic TB screening among clinically high-risk groups. Table 2 summarizes the barriers and facilitators to the implementation of chest X-ray in systematic TB screening among clinically high-risk groups organized by CFIR domains.

The key constructs for each domain are summarized as follows using illustrative quotations.

Domain 1: Innovation characteristics

In this domain, four constructs emerged as important factors influencing the implementation of chest X-rays as systematic TB screening. Facilitators were the relative advantage and quality of the evidence base of the innovation, whereas complexity and the cost of the intervention were barriers.

Relative advantage: All participants believed that using a chest X-ray screening tool was better than symptom-based screening. Implementing chest X-ray imaging in addition to symptom screening will definitely increase the sensitivity and specificity and the probability of detecting active TB and facilitate implementation.

> Chest X-ray is more sensitive when compared with symptom-based screening. "Um," most of the time, patients with active TB disease may not be symptomatic, so now that asymptomatic TB disease is common, we may miss more active TB disease patients with this symptom screening. especially in high-risk groups. . .. . . (IDI with participant 011)

In contrast, all participants identified radiation exposure as the main disadvantage of chest X-ray but not a barrier to implementation.

> Well, the harm of a chest X-ray is radiation exposure, "um," but the radiation harm is little. A person can have more exposure to radiation from nature. . . (IDI with participant 012)

Evidence base: Only one health worker highlighted the quality of the evidence and strength of the intervention as facilitators for implementation. Previously nationwide population-based TB surveys showed the superiority of chest X-rays over other tools.

> 10–11 years ago, we did a population-based TB prevalence survey that showed symptom screening misses a lot of active TB diseases, and most of the survey detected culture-positive TB cases after chest X-ray screening. . . (IDI with participant 011)

Complexity: Most of the participants believed that adopting chest X-ray as a systematic TB screening tool is complex. The complexity of screening is related to the burden it creates on radiologists and radiographers, lack of priority, and lack of awareness about screening protocols.

> Obviously, it is complex because, for example, the radiographers or radiology department will have a burden when we adopt it as a screening tool. If the burden increases, the waiting list will increase. . .. . . (IDI participant 009).

However, a few participants, on the other hand, had mixed feelings. For example, in a hospital setting where digital X-rays and radiologists are available, this process is not complex.

> Um, it depends on the type of facility. It is easy in a referral hospital like this because there is chest X-ray access and a radiologist for interpretation. . .. . . (IDI participant 013).

Cost: All participants emphasized that the cost of the intervention and the associated costs of implementing the intervention are large barriers to implementation.

> . . .. . .health facilities use chest X-ray as a means of generating income and facility revenue. A person pays for an X-ray after being X-rayed. . . (IDI with participant 011)

Few participants believed that health insurance services and exempting RVI patients from paying for every investigation found in the institution, such as a chest X-ray, complete blood count, and organ function tests in health facilities, decreased the burden.

> As I told you before, having health insurance has made it easy. Currently, every investigation is free in an HIV clinic, so it is easy to implement. (IDI with participant 007)

Domain 2: Outer setting

In this domain, two constructs, external policies and external support and financing, emerged as facilitators and barriers to implementing chest X-rays for systemic TB screening among clinically high-risk groups, respectively.

External policies and laws: Some of the participants said that policies, guidelines, and recommendations facilitated the implementation of the chest X-ray screening tool.

> . . .supporting a given recommendation with policies and guidelines will ease its implantation because it is used as a base by health workers. (IDI with participant 014)

External support and financing: Nearly all participants believed that support from the ministry, partners, and other stakeholders was not as expected and played a major role as a barrier to implementing chest X-ray for systematic TB screening.

> . . .I don't see support from the minister of health. (IDI with participant 005)

Domain 3: Inner settings

Four constructs emerged in this domain. Available resources and structural characteristics are facilitators, whereas relative priority and access to knowledge and information are barriers to implementing chest X-ray as systematic TB screening among clinically high-risk groups in health facilities.

Available resources: All participants suggested that the presence of a functional digital X-ray and radiologist at the hospital level greatly facilitates the implementation of chest X-ray systematic TB screening among high-risk groups, but complexity may still arise because of a high patient load and a lack of use of opportunities like artificial intelligence.

> . . .the first main thing is increased chest X-ray accessibility, digital X-ray imaging, and access to the network to improve radiologist reports. . . (IDI with participant 013)

Structural characteristics: Few participants said the presence of a chronic care system; an already structured facility has a better chance of implementing chest X-ray as a systematic TB screening tool among high-risk groups because the cascading new system is very costly.

> During the implementation of new initiatives or approaches, cascading a new structure is very costly, but we can use the already implemented systems or approaches in the hospitals. . . (IDI with participant 014)

Implementation climate (relative priority): Nearly all participants believed that even though systematic TB screening is given due attention, chest X-ray screening among clinically high-risk groups is not prioritized at all facility levels. Lack of practice, a lack of supportive monitoring and supervision, a lack of standard operating guidelines in hospitals, and using only symptoms show a lack of priority.

> TB screening has priority in different ways but not in chest X-ray. In almost every hospital, opening the cough OPD and helping patients use the service have been practiced. This trend continued even though it was inconsistent. The use of a chest X-ray for screening is not practiced. . . (IDI with participant 012)

Access to knowledge and information: Most study participants stated that even though evidence changes over time and providers must remain up-to-date, there was a lack of refresher training as well as updated information and guidelines.

> . . .we have requested for update training on newly published papers, but not yet given in the OPD. (IDI with participant 008)

Domain 4: Characteristics of individuals

In this domain, one construct emerged as important: knowledge and belief about innovation.

Knowledge and belief about the innovation: Lack of knowledge and belief among health professionals toward chest X-ray as a systematic TB screening tool among clinically high-risk groups was a barrier. More than half of the participants assumed that chest X-rays were diagnostic tests, not screening tools.

> . . .If a patient presents with TB symptom complex, we will send not only chest X-ray but also gene x-pert, LF LAM and others. There is no guideline that recommends the use of chest X-rays as screening tools. (IDI with participant 008)

In contrast, few participants believed that chest X-rays could be used as a TB screening tool among clinically high-risk groups.

Discussion

This study aimed to assess the facilitators and barriers to implementing a chest X-ray screening tool based on the CFIR construct.

Facilitators of implementing chest X-ray as systematic TB screening among clinically high-risk groups in tertiary hospitals

Major facilitators include relative advantage, external policies and laws, structural characteristics, and available resources.

Relative advantage

Relative advantage is the most relevant intervention characteristic that facilitates the implementation of chest X-ray as a systematic screening tool among clinically high-risk groups. Most healthcare workers believe that using a chest X-ray as a screening tool is more advantageous than symptom screening. This is primarily related to the sensitivity and specificity of screening tools, which helps to rule out other differential diagnoses, avoid delays in diagnosis, and decrease missed cases of TB. Chest X-rays increase the sensitivity and specificity of screening for TB, especially among clinically high-risk groups. A study done in India showed that chest X-ray had better sensitivity and specificity than symptom screening.[35] The yield of TB diagnoses increased by 38% as a result of screening methodologies that include chest X-ray in addition to symptoms.[13] According to the EXIT-TB project done in East Africa, the use of chest X-ray services for TB increased TB case detection and reduced delays in TB care.[36] The Global Plan recommends that, at minimum, 95% of people developing TB each year need to be diagnosed and treated, and that no one should be left behind. To find the missing people with TB, different approaches are needed depending on the local setting. Therefore, early screening and diagnosis lead to prompt treatment, recovery, and decreased catastrophic costs to the patient and family.

External policies

Global and national policies facilitate the implementation of sensitive screening tools such as digital chest X-rays and the use of artificial intelligence. According to half of the health workers in different facilities, they believe that the policies, guidelines, and recommendations regarding chest X-ray screening tools facilitate the implementation climate. This is because international and national commitments lead to leadership engagement, funding opportunities for implementation, working to achieve common goals, research, and innovations such as computer-aided diagnostics. The WHO addressed the use of chest X-ray for systematic TB screening among clinically high-risk groups.[37] The Global Plan to End TB advocates integrating sensitive TB screening and testing into other health services, with a focus on services that address common comorbidities or risk groups.[38] Guidelines for the National TB Program in Ethiopia recommend the use of chest X-ray screening algorithms in high-risk groups of the population.[4] All of these commitments indirectly show the use of sensitive TB screening tools.

Structural characteristics

The structural characteristics of the inner setting are one of the factors that influence implementation. It depends on the social architecture, age, maturity, and size of an organization. According to healthcare workers, implementing chest X-ray as a systematic TB screening algorithm is less complex in a healthcare setting with a mature, well-established healthcare system and adequate space for screening. A well-established healthcare facility helps implement integrative service delivery systematically.[39] Integrated service delivery combines multiple interrelated health services into one interaction. It has the potential to accelerate the finding of missing persons with TB while addressing other health conditions that contribute to TB morbidity and mortality (i.e., HIV, diabetes, undernutrition, tobacco use, and COVID-19).[40] It is a

less costly and more effective way to implement chest X-ray screening algorithms in clinically high-risk groups.

Available resources

Resources available in the inner setting are another construct that facilitates the implementation of chest X-rays as a systematic screening algorithm. Resources like the availability of digital X-rays and a radiologist are important for implementation. Unlike our study, a retrospective study using routine program data in 21 health facilities in East Africa showed insufficient resources as a challenge for TB screening.[41] Tertiary hospitals are equipped with X-ray machines and radiologists; this might be the case in our case.

Barriers to implementing chest X-ray as systematic TB screening among clinically high-risk groups in health facilities

Major barriers include the complexity of the intervention, relative priority in the health facilities, the cost of the intervention, individual knowledge and beliefs, and lack of consolidated programmatic guidance (external support).

Complexity

Perceived difficulty in implementation was the most relevant intervention characteristic that influenced the use of chest X-ray as a systematic TB screening tool among clinically high-risk groups. This was primarily related to increased direct and indirect costs, increased waiting time to get the screening, a lack of priority, and a lack of awareness about the screening protocol.

Cost of the innovation

The cost associated with chest X-ray use for systematic TB screening among high-risk groups in health facilities is a challenge for implementation, especially in lower- and middle-income countries. All healthcare professionals addressed the issue of chest X-ray implementation costs. Costs related to initial investment and running costs (including requirements for consumables, operational costs, and maintenance costs) will be high. According to the 2019 Mini Ethiopian Demographic and Health Survey, health insurance coverage in Ethiopia was 28.1%, and 12.32% in Addis Ababa.[42] A cross-sectional survey done in Ethiopia showed the mean cost of TB care to be $118 per episode, with 49% being the direct cost.[43] Patients are obliged to pay for chest X-ray in the current health system of Ethiopia, except for patients with HIV. This is similar to what has been observed in other East African countries.[41] This creates a burden on patients, leading to increased catastrophic costs and delays in diagnosis and treatment. It also creates economic hardship for the health system because hospitals use X-ray machines as revenue. Therefore, a broader dialog on the cost of TB screening, its funding, and accompanying resources is needed. Resource limitations redirected and limited donor aids will leave some interventions strained, and TB is no exception.

Relative priority

Priority is a common intervention characteristic that influences the implementation ecosystem. Most healthcare workers believe that chest X-ray screening algorithms among clinically high-risk groups are not prioritized by healthcare professionals in health facilities. Even though symptomatic TB screening had been implemented in health facilities by integrating symptom screening in OPDs in different disciplines and by establishing a cough OPD/one-stop-shop, the use of chest X-ray screening algorithms among clinically high-risk groups was not prioritized and implemented. Poor knowledge, attitudes, and practices related to ward chest X-ray screening algorithms, a lack of supportive monitoring and supervision, and using only symptoms show a lack of priority. However, the presence of guidelines and strategies that recommend the use of chest X-rays as systematic TB screening among clinically high-risk groups in health facilities shows the priority given by the minister of health.

Knowledge and beliefs of the individuals

Knowledge and beliefs of the individuals involved in the systematic TB screening influence the implementation of the intervention. Healthcare professionals' lack of knowledge about the screening algorithms in clinically high-risk groups is a barrier to the implementation of chest X-ray as a screening tool. This is similar to other multicenter studies done in Africa.[41] This was related to the poor dissemination workshop about the new guidelines, the lack of training, and continuous professional development courses in the facilities. This is similar to the study done in Uganda, which showed that a lack of training on TB guidelines is one of the challenges for implementation.[44]

Access to knowledge and information

Access to knowledge and information is an important construct in the inner setting that influences the implementation of new interventions. Knowledge comes first before implementing an effective intervention in a health facility because implementers should understand and absorb information before putting it into practice. The study showed that most healthcare workers believe there is a gap in accessing information regarding new scientific and updated guidelines. This is similar to the study done in Uganda, which showed that a lack of training on TB guidelines is one of the challenges for implementation.[44] This is related to a lack of priority for chest X-ray in systematic TB screening at the facility level, an underdeveloped continuous professional development curriculum, and poor engagement of the minister of health and other stakeholders.

External support and financing

Other barriers to implementing the intervention include a lack of external support and incentives. External support from the minister of health, the regional health bureau, and relevant stakeholders can be financial or technical. The participants believed that support from the ministry, partner, and other stakeholders was not as expected regarding chest X-ray use for systematic TB screening and that projects were for short periods and phased out without bringing sustainable change. This is a similar scenario in different projects, as seen in the EXIT TB project.[36] This leads to low commitment, low priority, financial burden, and finally difficulty in scaling the implementation of chest X-ray as systematic TB screening.

This study addresses the knowledge and information gap in the implementation of chest X-ray-guided systematic TB screening in Ethiopia. This is the first study to document the facilitators and barriers of chest X-ray systematic TB screening among clinically high-risk groups in tertiary hospitals in Ethiopia. The qualitative methodology and guiding framework allowed for a deeper exploration to capture the adaptability of the intervention in health facilities. The study has some limitations, such as using a qualitative design with a small sample size limits the accuracy and generalizability of the results; the richness of experience and perspective of the participants have reduced this limitation. Social desirability bias may have been introduced despite the precautions taken during the interviews. The collection and analysis of quantitative data may strengthen the evidence.

Conclusion

The CFIR domains and constructs were found to be valuable for structuring the in-depth interview guide and analyzing the resulting data. The facilitators and barriers identified in this study represent contextual factors that are actionable by healthcare workers and program coordinators. The most important facilitators, as determined by the participants, were relative advantage, external policies and laws, structural characteristics, and available resources, while the most important barriers to implementation were the complexity of the intervention, relative priority in the health facilities, the cost of the intervention, individual knowledge and beliefs, and a lack of consolidated programmatic guidance (external support). The specific facilitators and barriers found here could be considered when attempting to adopt chest X-ray screening algorithms in systematic TB screening among clinically high-risk groups in tertiary hospitals. Improving systematic TB screening in health facilities requires overcoming these identified barriers. Therefore, actionable recommendations should be developed based on the findings.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors without undue reservation.

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Author's contributions

YA, FW, and TM were involved in the study conception. YA was involved in data acquisition. All authors were also involved in the design, analysis, and/or interpretation of data. YA wrote the first draft, and FW and TM critically reviewed it. All authors reviewed the paper, provided comments, and approved the final version of the manuscript.

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Informed consent

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Trial registration

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Supplemental material

Supplemental material for this article is available online.

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