Original Research

Prevalence of pulmonary tuberculosis and associated factors among prisoners in Western Oromia, Ethiopia: A cross-sectional study

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Abstract	Article Information
The prevalence of tuberculosis among prison population is alarmingly high because the jails are like vibrant communities where vulnerable people gather. In 2017, researchers in Western Oromia, Ethiopia, set out to quantify the frequency of pulmonary tuberculosis and the variables that were thought to contribute to it. Data from 270 participants and sputum samples from 239 offenders were evaluated using GeneXpert to diagnose pulmonary tuberculosis. Inmates' risk of developing pulmonary tuberculosis was investigated using logistic regression analysis. In the jails, the prevalence of pulmonary tuberculosis was 0.7% overall (42/5644 or 744/100000), and it was 15.6% among suspected cases (42/270 or 744/100,000) with a 95% confidence interval of (11.5-20). The risk of pulmonary tuberculosis in prisons increased when inmates smoked cigarettes before being incarcerated (AOR=3.55, 95% CI 1.29, 9.78), were in close contact with a known tuberculosis patient (AOR=5.63; 95% CI 2.19, 14.41), had cellmates (AOR=3.51; 95% CI 1.34, 9.19), and had a body mass index (BMI) below 18.5 kg/m^2 (AOR=8.87; 95% CI 3.23, 24.37). Therefore, it is recommended that inmates in the prisons can be prevented by improving infection control procedures in correctional facilities and follow-up of patients with tuberculosis.	

INTRODUCTION

The tuberculosis (TB) is caused by Bacillus mycobacterium tuberculosis, an airborne pathogen. Although pulmonary tuberculosis usually affects the lungs, it can potentially affect other organs. According to Farhat, Shapiro, Kieser, Sultana, Jacobson, Victor, and Murray (2013), the bacteria that causes the disease can be expelled into the air when ill persons speak, cough, spit, sneeze, or sing.

Low- and middle-income nations account for nearly all cases (95%) and fatalities (99%). Ninety-nine percent of tuberculosis cases occur in just 22 nations. There are also significant financial burdens for families

affected by tuberculosis. On average, patients miss out on three to three months of work due to the disease, which can amount to as much as 30% of their yearly income (Chakaya, Khan, Ntoumi, Aklillu, Fatima, Mwaba, & Zumla, 2021). Inmates, intravenous drug users, migrants, and members of low-income and socially marginalized communities are disproportionately likely to contract tuberculosis. According to Kalonji, De Connick, Okenge, Kazumba, Kabengele, Tshimungu, & Giet (2016), TB is more common among incarcerated people in both developing and industrialized nations.

The number of tuberculosis treatments worldwide grew from 6 million in 2015 to 7 million in 2019 and from 7.1 million in 2016 to 7.1 million in 2019. Between 2015 and 2019, the number of people able to access tuberculosis preventative therapy climbed from 1 million to 2.2 million and 4.1 million, respectively. According to Gizachew, Hunegnaw, and Tiruneh (2017). Although tuberculosis (TB) can strike anybody at any time, the majority of cases occur in adults, men are more likely to contract the disease than women, and about 90% of TB infections occur in 30 countries with a high TB burden. Economic hardship, vulnerability, marginalization, stigma, and prejudice are common experiences for those afflicted with tuberculosis (TB) because it is a disease of poverty (Veiga, Varela, & De Só Valdez, 2021).

Overcrowding, poverty, and poor nutrition have all been recognized as risk factors for the disease for many years. Because of extreme overcrowding, bad nutrition, inadequate ventilation, and lack of access to healthcare, prisons are frequently high-risk settings for tuberculosis transmission. Along with being at high risk for tuberculosis, the fact that inmates are mostly male and usually between the ages of 15 and 45 is concerning. In addition, the majority of inmates come from low-income, uneducated backgrounds, which is associated with a greater rate of tuberculosis infection and transmission (Ilievska-Poposka, Zakoska, Pilovska-Spasovska, Simonovska, & Mitreski, 2018).

Some of the risk factors for tuberculosis (TB) include being in a crowded jail, having a low body mass index (BMI), having been treated for tuberculosis in the past, not eating enough, being malnourished, and having HIV (Grecherkos, Gelaw, & Tessema, 2016). For these reasons, prisons in low- and middle-income nations are likewise considered a high-risk zone for tuberculosis transmission. The frequency in the general population is predicted to be around ten to one hundred times lower in prisons (Melese & Demelash, 2017).

Research on tuberculosis in correctional facilities has shown an elevated rate in Ethiopia. Inmates at the Gamo Gofa jail in Southern Ethiopia had a tuberculosis prevalence of 3.2%, according to the study. In a 2017 study, Gizachew, Hunegnaw, and Tiruneh. The Hadiya Zone was the site of yet another study that found tuberculosis rates three times higher than the national average in southern Ethiopia. Unfortunately, research on tuberculosis (TB) prevalence in Western

Ethiopia is scant (Berihun, Nguse, & Gebretekle, 2018).

Inmates in the Wollega Zones in western Ethiopia were the subjects of this study, which aimed to determine the current tuberculosis prevalence rate. Finding out what causes tuberculosis infections in jails was the primary goal of the research. Officials and TB programmers might use this information to revamp jail TB preventive initiatives. So, it's important to figure out how common tuberculosis is among Wollega Zone inmates and what causes it.

MATERIALS AND METHODS

Three correctional facilities in Ethiopia's Western Oromia Region were the sites of a cross-sectional investigation. Three different Wollega towns Gimbi, Nekemte, and Dambi Dollo are home to these jails. In 1969, there were 2,228 inmates in the prisons, and during the study period, there were 1,447. All two hundred and seventy inmates who exhibited coughing or other suspicious signs during screening were enrolled in the research. This was used to include 106 inmates from Gimbi, 108 from Nekemte, and 56 from Dambi Dollo.

Individuals were chosen for the study if they had a history of coughing for at least two weeks prior to the date of data collection (Figure 1). Inmates who had previously reported coughing were subsequently tested for tuberculosis (TB) using the GeneXpert system.
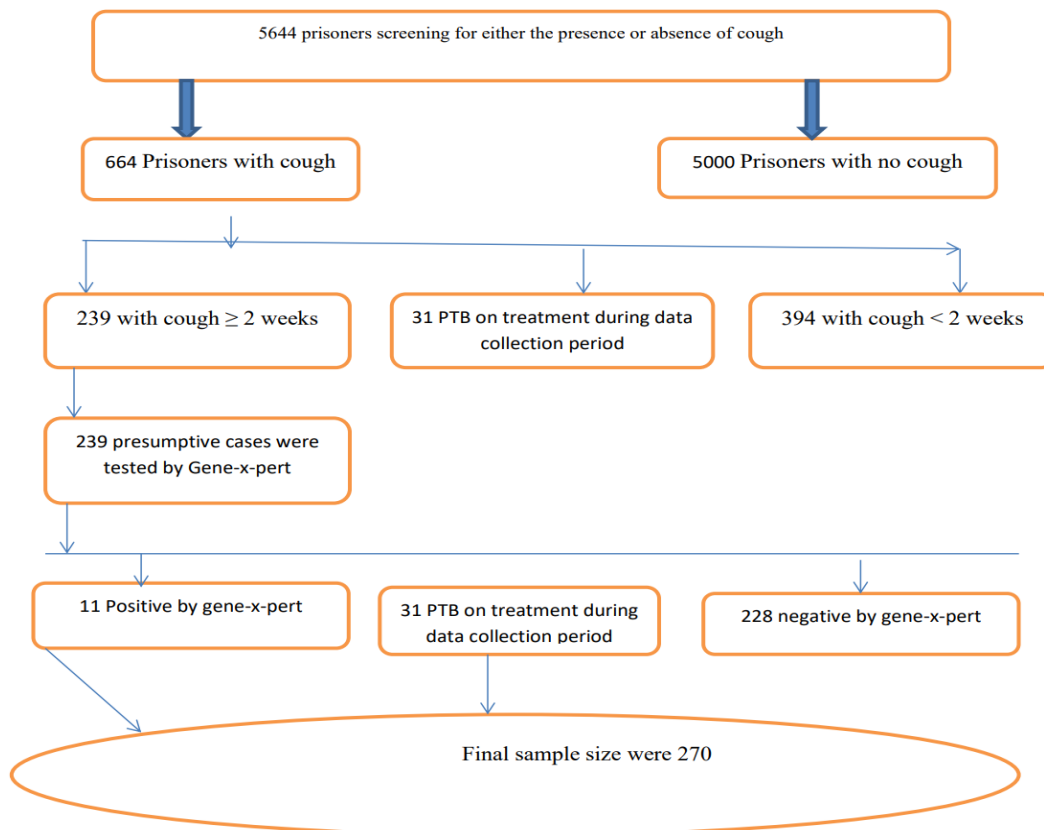

Figure 1 *Sampling Procedure*

The goal of the research was explained to prison health committees and in-house healthcare providers before data collecting began. Members of the health committees in each prison then helped register all of the convicts.

Sputum Collection and transportation

It is advised to submit one sputum specimen for the GeneXpert test. Collecting the sputum was done in a well-ventilated area outside of the lab or clinic. Inmates were made to cough up phlegm in order to clear their lower respiratory tracts. The participants were also instructed to rinse their mouths thoroughly with clean water prior to the collection of sputum.

The next step was to have them take deep breaths in and out three or four times, each time coughing up mucus from their chest. A 30-50 ml capacity "Falcon tube" was used for sputum collection. This was due to the fact that it possesses walls that permit easy labeling and is translucent. After that, a triple-package was used to transfer the sputum to the hospital for testing. The laboratory test followed the correct technique for applying the GeneXpert test (Terzi, Aydemir, Karakece, Koroglu, & Altindis, 2019).

Weight and height measurements

Our weight was 0.1 kg and our height was 0.1 cm, as measured on the scale. To find a person's body mass index (BMI), we divided their height squared by their weight in kilos. If the body mass index (BMI) is below 15.9 kg/m^2, then the nutritional status is severe. If it is between 16.7 and 16.7 kg/m^2, then it is mild. If it is between 17.4 and 18.4 kg/m^2, then it is mild. If it is greater than 18.4 kg/m^2, then it is well-nourished.

Data quality control

There was a one-day training session for supervisors and data collectors. Then, in Shambu town prison, 5% of the sample was used to pre-test the data collection techniques. With the GeneXpert Diagnostic System, every sample goes through an automated internal quality control process. The test cartridge of GeneXpert includes an inbuilt quality control mechanism. Furthermore, prior to using these cartridges for patient samples, laboratory staff had tested them with known positive and negative specimens.

Data analysis using statistical methods

For this study, we imported the data into Epidata 3.1 and exported it to SPSS 20. In order to describe the data, summary statistical measures were computed, including percentage, mean, standard deviation, and frequency. To further investigate potential associations between the explanatory variables and TB status in the lungs, bivariate logistic regression analysis was employed. We were able to identify factors influencing pulmonary tuberculosis by included variables in the multivariable logistic regression model with p-values less than 0.25. To evaluate the impact of the independent variables on PTB status, we computed odds ratios and 95% CIs. When the p-value was 0.05 or lower, we said that the link was statistically significant.

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Operational definitions

Screening patients for tuberculosis is a critical step in identifying persons with symptoms and results compatible with the disease, according to the World Health Organization (2013). One significant symptom to look out for is a cough that lasts two weeks or longer.

According to Thomas, Thiruvengadam, Rani, Gangadhar, Yadav, Paluru, & Kaur (2021), fever, night sweats, and weight loss are signs that might be used to suspect tuberculosis.

At the time of data collection, a patient with a tuberculosis diagnosis who is also taking anti-TB medication is considered an existing TB case.

When a person's body mass index (BMI) is less than 18.5 kg/m^2 (Ravaoarisoa, Randriamanantsaina, Rakotonirina, Rakotom anga, Donnen, & Dramaix, 2018), it is considered malnutrition.

If the data collector noticed that the house had enough windows and doors to let fresh air into the rooms while they were collecting data, then it is considered to be in good ventilation condition. If the data collector saw that the house lacked proper ventilation, meaning that fresh air couldn't enter the rooms, then it was considered a bad ventilation condition. The lower respiratory system consists of the trachea, bronchi, alveoli in the bronchi, and the entire lung.

Those who had been in close proximity to a person with pulmonary tuberculosis for more than fifteen hours per week or more than one hundred and eighty hours overall during an infectious period, which is the time frame beginning three months prior to the collection of the first culture-positive sputum, were considered to have had contact with tuberculosis patients (Hussien & Ameni, 2021). A jail cell or prison cell is a tiny chamber in a jail or prison where an inmate is housed. The cleanliness, hygiene services, and furnishings of prison cells can vary substantially from one country to another and even from one inmate's sentence to another.

To be considered a smoker, one must have smoked at least one cigarette in the past 28 days and a lifetime total of 100 cigarettes (including cigars, cigarillos, hand-rolled cigarettes, etc.).

The energizing effects of chewing khat—a plant whose leaves and stem tips are called as "qaad" or "jaad" in Somalia—are experienced by the user.

RESULTS AND DISCUSSION

Results

Characteristics of study participants

Out of 5,644 inmates evaluated, 644 (11.4%) had a history of cough; this included 5441 (96.4%) males and 203 (3.6%) females. Among the coughing subjects, 239 (4.2% of the total) had a cough duration of 2 weeks or more, whereas 394 (7%) had a shorter duration. Along with the 31 PTB patients who were already receiving treatment, 239 patients whose coughs had lasted two weeks or more took part in the trial. Of these 270 inmates, 97.4% were men, 57.4% were married, and 53.7% had completed elementary school. Table 1 shows that 111 (or 41.1% of the total) suspected PTB case-patients had a history of chit chewing and that nearly half had a smoking history, with a median smoking duration of 7 years prior to incarceration.

Table 1

Inmates from the Wollega zones of Western Oromia, Ethiopia, who were part of the 2017 study (n=270)

Variables	Frequency	Percent
Sex		
Male	263	97.4%
Female	7	2.6%
Age		
15-24	102	37.8%
25-34	84	31.1%
35-44	39	14.4%
>45	45	16.7%
Religion		
Muslim	49	18.1%
Protestant	134	49.6%
Orthodox	72	26.7%
Adventist	14	5.2%
Other	1	0.4%
Ethnicity		
Oromo	246	91.1%
Amhara	18	6.7%
Others	6	2.3%
Marital status		
Single	100	37%
Married	155	57.4%
Others	15	5.5%
Educational status		
No formal education	81	30%
Primary school (1-8)	145	53.7%
Secondary school (9-12)	35	13%
College and /or university (12+)	9	3.3%
Occupation before imprisonment		
Government employee	9	3.3%
Farmer	152	56.3%
Merchant	25	9.3%
Daily labor	29	10.7%
Student	43	15.9%
Other	13	2.4%
Residence		
Rural	203	75.2%
Urban	67	24.8%
Cigarette smoking		
Yes	115	42.6%
No	155	57.4%%
''Khat''chewing		
Yes	111	41.1%
No	159	58.9%

Of the participants with a history of incarceration, 179 (66.3% of the total) had spent less than two years in their present facility, with a median of one year, and 34.4% were inmates who shared cells with tuberculosis patients. Out of the total number of participants, 160 (or 59.3%) had stayed with someone who had a persistent cough for at least three weeks. More over half of the inmates in the survey (154 out of 260) also reported sharing food and drink with their fellows. Table 2 shows that 218 inmates, or 80.7% of the total, reside in prisons with more than 100 inmates per cell, and that 153 inmates, or 56.7% of the total, did not get any visits or food from family members while incarcerated.

Table 2

Jail characteristics of the 2017 Wollega zone, Western Oromia, Ethiopia jail population (n=270).

Character/variables	Labels	Frequency	Percent
Duration of stay in current prison	≤24 months	179	66.3%
	.>24 months	91	33.7%
Sharing cell with TB Patient	Yes	93	34.4%
	No	177	65.6%
Housing ventilation condition	Good	89	33%
	Bad	181	67%
Duration of stay with Person who have persistent cough	<3 weeks	107	39.6%
	≥3 weeks	160	59.3%
	I don't know	3	1.1%
Sharing drinking and eating materials with other persons	Yes	154	57%
	No	116	43%
Support from family in terms of visit and bringing food	I don't have	153	56.7%
	visit only	18	6.7%
	Food only	3	1.1%
	visit and food	96	35.6%
Prisoners per cell	≤100	52	19.3%
	>100	218	80.7%

Out of all the participants in the study, 133 (or 49.3%) had some kind of medical care for their current ailment; 32 (11.9%) of those had gone to the prison's clinic, 16 (5.9%) to other places, and 85 (31.5%) to both. About 70 people in the study (or 25.9%) had personal contact with a tuberculosis patient at home, and 56 people (or 20.7%) had been hospitalized in the past. Thirteen percent had hypertension or diabetes mellitus, and another seventeen percent were treated for various chronic conditions. Table 3 shows that out of the total study participants, 60 (22.2%) had a body mass index (BMI) below 18.5 kg/m^2 with a median BMI of 20.5 kg/m^2, and 3 (1.1%) tested positive for HIV.

Table 3

Researchers in 2017 studied the health status of inmates at the Wollega Zone Prison in western Oromia, Ethiopia.

Character/variables	Labels	Frequency	Percent
Treatment for your current complaint	Yes	133	49.3%
	No	137	50.7%
Place of treatment for current symptom	Health institution	16	5.9%
	Prison's clinic	32	11.9%
	Both	85	31.5%
History of contact with known TB patient at home	Yes	70	25.9%
	No	200	74.1%
History of hospitalized	Yes	56	20.7%
	No	214	79.35
Diagnosed for Diabetic mellitus/Hypertension	yes	27	10%
	No	225	83.3%
	I don't know	15	5.6%
Treatment for chronic diseases	Yes	19	7%
	No	67	24.8%
Body mass index	< 18.5 kg/m2	60	22.2%
	.≥ 18.5kg/m2	210	77.8%
HIV test result	Positive	3	1.1%
	Negative	267	98.9%

Prevalence of pulmonary TB among prisoners

Pulmonary tuberculosis was found in 0.7% of total prisoners (42/5644 or 744/100000), and in 42/270 (15.6% with a 95% CI (11.5-20)) among suspected cases in jails in Wollega zones. The pulmonary tuberculosis case rate was 744 per 100,000 people, with a 95% confidence interval of 344–1832. Gimbi Prison had the highest concentration of cases, with 14 previously reported cases and 6 new cases. Among the individuals who took part in the study, 8.9% tested positive for Mycobacterium tuberculosis (MTB) after two weeks of coughing, 19.7% after four weeks, and 21.4% after six weeks (Table 4).

Table 4

Prevalence of TB among the study population in prisons of Wollega zones, Western Oromia, Ethiopia, 2017 (n=270)

Name of prisons	Total evaluated	Newly diagnosed TB cases	Existing TB cases on treatment	Prevalence among presumptive cases
Gimbi prison	106	6	14	18.8%
Nekemte prison	108	5	12	15.7%
Dambi Dollo prison	56	0	5	8.9%
Total	270	11	31	15.6% (overall prevalence)

Factors associated with pulmonary TB

The following factors were found to be associated with the prevalence of tuberculosis, according to Table 5: inmates' history of cigarette smoking (AOR = 3.56, 95% CI 1.29, 9.78), their history of home contact with known tuberculosis patients (AOR = 5.63, 95% CI 2.19, 14.41), the length of time they have been in prison (AOR = 3.21, 95% CI 1.12, 9.17), and a low body mass index (<18.5 kg/m2) (AOR = 8.87, 95% CI 3.23, 24.37).

Table 5

Multivariate assessments of PTB risk factors in Wollega Zone prisoners, Western Oromia, Ethiopia, 2017.

Variables	Pulmonary TB detected		COR(95% CI)	AOR(95% CI)
	Yes	NO		
Smoking cigarette				
Yes	34(29.6)	81(70.4%)	7.7(3.4-17.5)	3.6(1.3-9.8)
No	8(5.2)	147(94.8%)	1	1
History of contact with TB patient at home				
Yes	29(41.4)	23(67.6%)	10.2(4.9-21.2)	5.6(2.2-14.41)
No	13(6.5)	205(86.9%)	1	1
Sharing cell with TB Patient				
Yes	29(31.2)	64(68.8%)	5.7(2.8-11.7)	3.51(1.3-9.2)
No	13(7.3)	164(92.7%)	1	1
Body mass index				
<18.5kg/m2	26(43.3)	34(56.7%)	9.3(4.5-19.1)	8.9(3.2-24.4)
	16(7.6%)	194(92.4%)	1	1

Crude association (COR) refers to the process of testing for the presence of an association between a single predictor and an outcome. When testing for the presence of an association and each predictor's individual main impact, we can identify potential main effects, confounders, mediators, and interaction effects by modifying the predictors. This method is called adjusted association (AOR).

Discussion

With a confidence interval (CI) of 134–1832, this study found that there are around 744 instances of pulmonary tuberculosis (TB) per 100,000 inmates in correctional facilities. The magnitude of tuberculosis among suspects was 15.6% (95% CI 11.5, 20), surpassing the population-level prevalence of 108 per 100,000. The southern Ethiopian region of Gamo Gofa has a lower rate of 623 per 100,000 inmates, but this statistic suggests a greater overall prevalence. Melese and Demelash (2017) and Gebrecherkos, Gelaw, and Tessema (2016) found that 9.4% of inmates at North Gondar Prison were from Eastern Ethiopia. The variation in the study population could be the cause of the difference.

According to Shrestha, Yadav, Gautam, Mulmi, Baral, and Pokharel (2019), the prevalence that has been noted is seven times greater than the whole population. While collecting data, further tuberculosis (TB) cases were discovered, suggesting that there may be undiscovered TB inmates who could infect other inmates. This highlights the importance of routine tuberculosis screening upon intake. The fact that Gene-Expertise outperforms sputum smear microscopy in predicting pulmonary tuberculosis (Fuge & Ayanto, 2016) suggests that using GeneXpert could lead to improved case detection. Tobacco use significantly increased the likelihood of PTB was examined in this research. A study in Tanzania (Rodal, 2018) and another in southern Ethiopia (Adegbite, Edoa, Agbo, Dejon-Agobé, Essone, Lotola-Mougeni,... & Grobusch, 2020) came to similar conclusions. Consistent with the study carried out in East Wollega, it was found that sharing jail cells is substantially linked to tuberculosis infection (Chekesa, Gumi, Chanyalew, Zewude, & Ameni, 2020). This is due to the fact that it is quite easy for non-infected people to breathe in droplets from infected people when they are in close quarters. This study and others in Ethiopian prisons found a strong correlation between prior contact with a known tuberculosis patient and the development of pulmonary tuberculosis (AOR = 5.63, 95% CI: 2.19, 14.41) (Tsegaye, Blumenthal, Jain, Sun, Young, Manyazewal & McCutchan, 2019). Possible explanations for this correlation include increased risk of person-to-person transmission in close quarters with an infected individual and the reactivation of latent tuberculosis infection as a result of immune system deterioration.

Pulmonary TB positive was shown to be substantially linked with nutritional status (BMI) in the present study (AOR = 8.87, 95% CI 3.23-24.37). According to a study in Wollega Zones (Tadesse, Merdassa, Abdisa, & Tolossa, 2022), low body mass index (i.e., ≤ 18.5 kg/m2) was identified as a risk factor for tuberculosis (TB), and those with a BMI below 18.5 kg/m2 were more likely to develop PTB than those with a BMI of 18.5 kg/m2 or higher. This may be due to the fact that stunted growth and the reactivation of latent tuberculosis are both linked to nutritional deficiencies. Prior research in the Somali Region of East Ethiopia, namely at the Jigjiga Public Health Facilities (Geberemeskel, Woldeyohannes, Demisie, & Demisie, 2018), lends credence to this theory. As tuberculosis (TB) can either cause or put people at risk for malnutrition, this connection works both ways. So, in this cross-sectional study, we cannot directly attribute malnutrition to the nutritional status of patients with or without active PTB, even though it was a significant predictor in the multivariate analysis.

CONCLUSIONS

According to this research, there is a significant number of contagious and undiscovered cases of tuberculosis (PTB) in jails located in Wollega Zones. Inmates in Wollega Zones were shown to be more likely to have PTB if they had a history of cigarette smoking before incarceration, had close contact with known tuberculosis patients at home, and had a high body mass index. In a

nutshell, the jail population is at a higher risk of contracting tuberculosis (PTB) due to the high prevalence and related risk factors for the disease. Additionally, this may pose a significant risk to the public's health in the area.

RECOMMENDATIONS

To limit the protracted transmission of tuberculosis (TB) in prisons, it is necessary to screen inmates upon arrival and departure in order to detect infectious cases early on, which will delay diagnosis even more. Inmates need enough fresh air and a varied diet, so make sure they get both. Prison tuberculosis control methods should prioritize isolating patients who test positive for smears for the entire first phase of directly observed treatment (DOTS) and providing ongoing health information about the mode of PTB and how to prevent it. For the purpose of detecting and screening suspected cases for PTB, the health committee should be fortified. Supportive supervision of prison health staff, monitoring of tuberculosis preventive and care services in prisons, and periodic mass screening of incarcerated individuals to determine the efficacy of their treatment after release from prison

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DECLARATION

The authors declare that there is no conflict of interest among the researchers.

DATA AVAILABILITY STATEMENT

The data generated from the field experiments are available from the corresponding author upon request.

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