ORIGINAL ARTICLE

Incidence of Latent Tuberculosis Infection (LTBI) Following Incarceration among New Prisoners

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Background: The occurrence of tuberculosis (TB) in prisoners is higher than in the general population.

Objective: To determine the incidence of Latent tuberculosis infection (LTBI) in newly incarcerated persons in southern Thailand.

Materials and Methods: A prospective cohort study was conducted between January 2020 and December 2020 in all new inmates aged 15 years or older. Within two weeks of imprisonment, chest radiography and the two-step tuberculin skin test (TST) were performed. Participants with a negative TST underwent a repeat one-step TST at six months. A positive TST at six months without evidence of TB indicated new LTBI.

Results: Six hundred two male inmates were enrolled. Fifty-one prisoners (8.5%) were excluded due to a history of previous incarceration for 4.1%, history of TB for 0.8%, household contact with TB cases for 2.1%, and refusal to participate for 1.3%. The remaining 551 inmates participated in the study. The average age was 31.1 years. The two-step TST was completed in 507 inmates (92.0%). Two hundred thirteen out of 551 participants (38.7%) initially tested positive. Follow-up was conducted on 290 participants. Only 53 participants (9.6%) completed the study protocol at six months due to COVID-19 pandemic lockdown. Tuberculin conversion was found in five inmates (9.4%).

Conclusion: LTBI prevalence and incidence rates among Thai inmates are high. Individuals with negative LTBI test at initial imprisonment were at high risk of acquiring infection and should be followed to detect conversion and offered LTBI treatment.

Keywords: Latent tuberculosis infection; Prison; Tuberculin skin test

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Thailand has the second largest inmate population in Asia at 377 per 100,000 population with a total of 262,319 inmates in 2021[1]. While the incidence of tuberculosis (TB) is declining in community settings across Thailand[2], the number of active TB cases among the incarcerated population has risen by nearly five times between 2016 and 2019[3]. Globally, TB incidence in prisons is higher than in the community[4,5]. One recent meta-analysis reported the incidence of TB among incarcerated persons was 4.1- to 26.9-fold higher than the corresponding general population and the prevalence of active TB disease in prisoners after imprisonment usually exceeds 500 per 100,000 inmates in all global regions except North America, the Eastern Mediterranean, and the Western Pacific[5].

In Thailand, the 2017 nationwide prevalence of pulmonary TB in Thai prisoners was 873 per 100,000 inmates[6], and another study[7] reported that 38%, or eight out of 21 culture-positive *Mycobacterium tuberculosis* (MTB) isolates had DNA fingerprints matching those of another inmate housed in the same room or the same dormitory. Patient factors predisposing incarcerated people to TB include the high rates of low socio-economic status, alcohol consumption, injectable drug use, HIV, and treatment defaults. Overcrowding and poor ventilation in prisons as well as the lack of microbiological or radiological diagnostic facilities and preventive screening with treatment strategies further perpetuate the transmission of TB[4,8-10]. Due to the correlation between incarceration and TB, individuals in prisons are the most vulnerable to contracting the disease[11,12].

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The TB Control Program in Thai prisons is still limited to passive case-finding and treatment of reported symptomatic cases. Cross-sectional symptom-based and chest X-ray (CXR) screenings are occasionally applied[6,13,14]. Even though active case finding, and treatment remain the keys for TB control, this approach alone may not be sufficient to achieve the World Health Organization (WHO) End TB Strategy targets[4,15]. Since early detection of newly infected TB cases with prompt treatment of latent tuberculosis infection (LTBI) may prevent TB disease and decrease the spread of TB in prisons[9,16], an adjunctive strategy to detect these cases is required. Currently, no prospective study has addressed the incidence of TB infection in a Thai prison. This lack of data may impede the development of interventions to combat TB. The present study primary objective was to assess the incidence of LTBI based on tuberculin skin test (TST) among new prisoners and the secondary objectives were to assess the prevalence of LTBI and TB among new prisoners at the time of entry and six months of follow-up during incarceration.

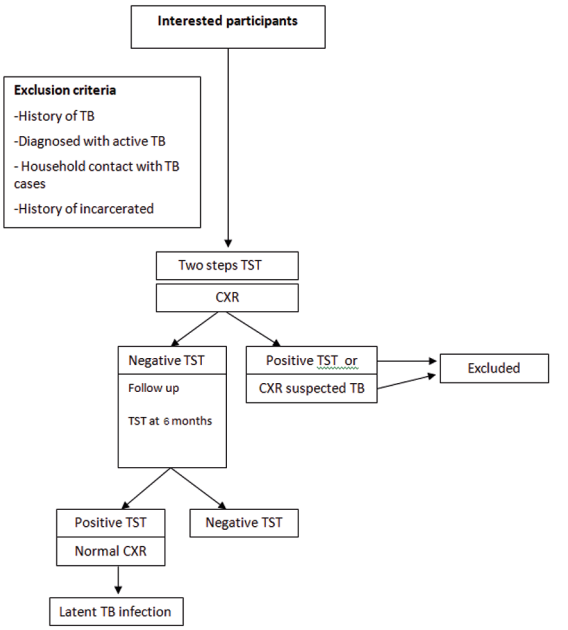

Figure 1. Study protocol.

TB=tuberculosis; TST=tuberculin skin test; CXR=chest radiography

Material and Method

Study design and population

A prospective cohort study was planned between January 2020 and December 2021 at Songkhla Provincial Prison. The inclusion criteria were newly incarcerated Thai inmates aged 15 years or older and incarcerated in prison not longer than two weeks before study enrollment. The exclusion criteria included 1) a history of TB, 2) household contact with TB cases, defined by living in the same dwelling as the TB case during the two months before the diagnosis, 3) diagnosis with active TB, 4) refusal to participate, and 5) a history of allergy to purified protein derivatives. TB education and the study protocol were explained and delivered to all participants, and interested participants were asked to provide written informed consent.

Ethical approval

The present study was approved by the Department of Corrections, Ministry of Justice, Thailand, and the Research Ethics Committee of Songkhla Hospital, Thailand (SKH IRB 209-Md-I3B-0611106). All participants provided signed informed consent.

Study protocol

The study protocol included a questionnaire to collect baseline characteristics of the participants, such as age, co-morbidities, history of incarceration, history of close TB contact, history of previous TB disease, and current TB symptoms. CXR were taken and interpreted by radiologists. Participants with positive screening or suspected CXR underwent sputum smear microscopy and GeneXpert MTB testing to investigate active TB. Participants diagnosed with active TB were referred to Songkhla Hospital for TB treatment. Figure 1 shows the study population flow chart.

Participants who showed no signs of active TB through symptom screening and CXR underwent a two-step tuberculin test (TST). Participants who had positive TST at initial screening were excluded from the study. Those who had negative TST results underwent a repeat test after six months. If the TST results were positive, they underwent CXR and symptom screening for active TB. If these tests were negative for evidence of active TB, they were diagnosed with new TB infection and offered latent TB treatment.

Tuberculin skin test and interpretation

According to the two-step TST protocol, all participants who initially tested negative underwent a repeat TST after one to three weeks. A positive TST result was considered when the induration was

10 mm or more in diameter[17,18]. A boosted reaction was defined as an induration of less than 10 mm on the first TST and an induration of 10 mm or more on the second TST. For HIV-positive participants with an induration of 5 mm or more were considered positive.

Statistical analysis

Continuous data were described using mean and standard deviation, while categorical data were described using percentages The incidence of new LTBI was calculated by the number of new LTBI as a proportion of all participants follow up at six months of incarceration. The prevalence rate was calculated by the number of LTBI or TB as a proportion of new prisoners who participated in the present study.

Results

The present study was intended to be conducted between January 2020 and December 2021, however, due to the emergence of the COVID-19 pandemic, the study protocol was done for only one year between January 2020 and December 2020.

During the study period, 602 new inmates were admitted to the facility. All of them were men, with an average age of 31.1 years, ranging from 18 to 75. Out of these, 51 prisoners (8.5%) were excluded from the study due to reasons such as history of previous incarceration for 4.2%, a history of TB for 0.8%, household contact with active TB cases for 2.2%, or refusal to participate for 1.3% (as shown in Table 1). Eventually, 551 participants were included in the initial study process. Among them, two participants had CXR results indicative of active TB. Additionally, 5.3% (29 out of 551 participants) had underlying medical conditions, which were diabetes mellitus for four, hypertension for six, and HIV disease for three. In a study conducted at Songkhla Provincial Prison, it was found that 38.7% (213 out of 551 participants) (95% confidence interval [CI] 0.35 to 0.43) had positive TST results with induration sizes of 10 mm or more. This indicated that the prevalence of TB infection at the time of entry into the prison was 38,657 per 100,000 inmates. Out of the 290 participants who had TST results less than 10 mm, only 18.3% (53 participants) had a follow-up TST after six months of imprisonment (Table 2). Out of these 53 participants, five of them (9.4%) (95% CI 0.01 to 0.18) tested positive for TB infection (TST converted). However, their CXR results showed no signs of active TB infection (as shown in Figure 2).

Table 1. Baseline characteristics of the participants

Characteristic	Total (n=602)
Age (years); mean (range)	31.1 (18 to 75)
Co-morbid condition; n (%)	29 (4.8)
HIV status (by history); n (%)	3 (0.5)
History of previous incarceration; n (%)	25 (4.2)
History of previous active TB; n (%)	5 (0.8)
History of previous contact with active TB; n (%)	13 (2.2)

TB=tuberculosis

Discussion

According to a study, the prevalence of active TB among new prisoners was 3.4% (336 out of 100,000 inmates), which was twice as high as the general population of Thailand[2]. Another study conducted in southern Thailand found 2.72% of incarcerated prisoners had TB based on an annual CXR study[19]. The prevalence of TB in this group was also higher than that of the general population[5]. Therefore, the prevalence of active TB in new inmates in southern Thailand has not decreased over time.

In the present study, the authors found that 38.7% of new prisoners had LTBI, which is lower than the 46.5% prevalence found among Thai inmates imprisoned for varying periods, with average duration of incarceration of 5.8 years[6]. After six months of imprisonment, the incidence of new TB infection among new prisoners was 9.4%. This rate is slightly higher than the 6-month TB infection incidence rate of 7.6% in Iranian inmates[20]. It is important to note that the prevalence of TB infection continues to increase after imprisonment, with an annual risk of 15.2% to 27.1%[12,20-22]. The present study highlights the high prevalence and incidence of LTBI in southern Thai prisons. Therefore, it is crucial to implement

Table 2. Baseline characteristics of the participants after 6 months of follow-up

Characteristics	Total (n=53)	TST positive (n=5)	TST negative (n=48)	95% CI
Age (years); mean (range)	30.2 (18 to 62)	30.8 (18 to 46)	30.1 (18 to 62)	26.98 to 33.4
Co-morbid condition	3	0	3	–0.01 to 0.12
HIV status	1	1	0	–0.02 to 0.06

TST=tuberculin skin test; CI=confidence interval

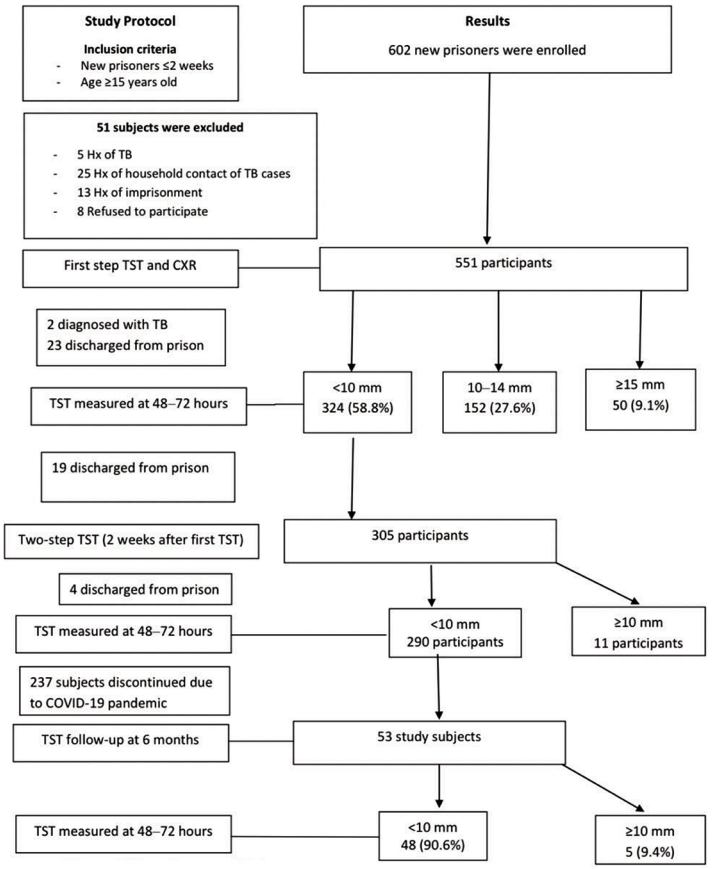

Figure 2. Flow diagram of the study process.

TST=tuberculin skin test; CXR=chest radiography; TB=tuberculosis

LTBI screening to detect new TB infections, along with active TB case-finding and early treatment of active TB. It is important to note that the present study has limitations. Firstly, while either the TST or interferon-γ release assay (IGRA) can be used to test for LTBI[23], the Bacillus Calmette Guérin vaccination may reduce the specificity of TST. IGRA was not used due to it being more expensive and technically more complex to perform, which may have resulted in false positive TST results being reported. However, a previous report showed that discordant IGRA–/TST+ results were only present in 8.5% of Thai prisoners(6). Secondly, 237 out of 290 participants (81.7%) were lost due to Songkhla Provincial Prison being the first prison for new prisoners who were able to post bail while awaiting trial. Thirdly, some prisoners were only imprisoned for a few weeks to a few months before being released. Fourthly, the emergence of the COVID-19 pandemic caused a shutdown of prisons, meaning that the authors were unable to follow inmates beyond six months. Nevertheless, the present study found a high incidence of LTBI in new prisoners, indicating that individuals with a negative test for LTBI at the time of entry to prison were at high risk of acquiring infection. Therefore, they should be monitored to detect converters and offered LTBI treatment.

Conclusion

The prevalence and incidence of LTBI are high in Thai prisons. To address this issue, it is recommended to implement LTBI screening and treatment before entry into the prison. Additionally, monitoring of TST conversion after imprisonment can help detect new TB infections. It is also important to conduct active TB case-finding and provide early treatment for those with active TB.

What is already known on this topic?

We already know that the prevalence of LTBI among prisoners is high, but we never know the true incidence of LTBI among new prisoners.

What does this study add?

The incidence of LTBI among new prisoners is 9.4% in six months.

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Conflicts of interest

The authors declare no conflict of interest.

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