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## Prevalence of tuberculosis (TB), including multi-drug-resistant and extensively-drug-resistant TB, and association with occupation in adults at Sirindhorn Hospital, Bangkok

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### ABSTRACT

**Background:** Tuberculosis (TB) affects both child and adult populations worldwide.

**Objectives:** This retrospective study was conducted to survey the prevalence of TB and its association with patient occupation in an adult population diagnosed with TB at Sirindhorn Hospital in 2018.

**Methods:** Data were extracted from the medical records of 186 patients with TB, and prevalence and odds ratios were calculated.

**Results:** Pulmonary (83.3%) and extrapulmonary TB (17.7%) were observed among the cases. Overall, 70.4% of cases were male and 29.6% were female. Mono-drug-resistant TB, multi-drug-resistant TB and extensively-drug-resistant TB were observed in 2.72%, 4.1% and 0.68% of cases, respectively. Although not statistically significant, individuals with comorbidities had a 2.16-fold [95% confidence interval (CI) 0.33–13.98] higher risk of TB compared with those without comorbidities. Unemployed patients with TB were 4-fold (95% CI 0.82–19.42) more likely to have hypertension than employed patients or traders. The risk of TB among patients with human immunodeficiency virus (HIV) infection was 2.22-fold (95% CI 0.93–5.31) higher among females compared with males, and relapsed patients had a 0.92-fold (95% CI 0.19–4.47) lower risk of HIV infection as a comorbidity compared with new TB cases.

**Conclusion:** Patient occupation could play a role in the prevalence of TB among communities. The highest prevalence of TB was observed among unemployed subjects, and unemployed patients with TB were more likely to have hypertension as a comorbidity. Mapping the zones/areas of residence for patients with TB could assist in identifying TB hot spots, and could improve understanding of the drivers of the high TB burden and associated socio-economic factors. More studies are required to further understand the drivers that are leading to the high TB burden and the risks posed by occupations.

### Introduction

Tuberculosis (TB), caused by the bacteria *Mycobacterium tuberculosis*, is among the top 10 causes of death, with 2 billion infections reported globally (World Health Organization, 2020). In 2019, approximately 1.2 million deaths were reported. TB infection is preventable with an infant vaccine (Bacillus Calmette-Guérin); however, the vaccine cannot prevent primary TB infection or reactivation of latent TB infection. Treatment using anti-TB drugs with direct observed therapy is available globally.

In Thailand, lower treatment success has been observed in individuals with both TB and human immunodeficiency virus (HIV-1) infection compared with those with TB without HIV-1 infection (Gatechompol et al., 2019). In 2015, Thailand was placed on the World Health Organization (WHO) list of 30 high TB burden countries, 30 high TB/HIV burden countries, and 30 high multi-drug-resistant/rifampicin-resistant (MDR/RR) TB burden countries, but in 2021, Thailand was removed from the list of countries with a high MDR/RR-TB burden. Despite the reduction in the MDR/RR-TB burden, Thailand is still on the list of 30 high TB burden and high TB/HIV burden countries. Dia-

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betes mellitus has been observed among patients with TB, with the highest prevalence observed in North America, Oceania and Asia (23.6%, 23.2% and 17%, respectively) (Gupta et al., 2011; Workneh et al., 2017; Cadena et al., 2019). An association between hypertension, diabetes mellitus and HIV in patients with TB has been reported, although a direct association between TB and hypertension is yet to be established (Seegert et al., 2017). Socio-economic factors have been associated with the TB burden globally, and in Asia, lower socio-economic status has been associated with increased risk of TB (Jiamsakul et al., 2018). The incidence of TB in Thailand is higher in males compared with females, and is most prevalent in adults aged >65 years (World Health Organization, 2020). To the authors' knowledge, no studies to date have reported on the association between TB and occupation. As such, this retrospective study was conducted to investigate the prevalence of TB, and the association between TB and occupation in an adult population diagnosed with TB at Sirindhorn Hospital in 2018. Specifically, this study surveyed the prevalence of pulmonary TB, MDR-TB and extensively-drug-resistant (XDR) TB among adult patients, and investigated if there was any association between TB and occupation.

## Methods

### Study design, population and setting

Thailand is an upper-middle-income country with a vibrant health system, and is a migration hub for South-East Asia and beyond. Thailand experiences high turnover of tourists and migrants from many parts of the world, with over 38 million visitors registered in 2018. This high turnover may increase the risk of infectious diseases from around the world. According to the Thailand migration report 2019, it is estimated that the non-Thai population living in Thailand is approximately 4.9 million (<https://www.iom.int/news/united-nations-launches-thailand-migration-report-2019>). Thus, imported infectious diseases represent a likely public health challenge.

Bangkok, the capital city of Thailand, has 50 districts and a total population of approximately 10.5 million (as of 2020) (<https://worldpopulationreview.com/world-cities/bangkok-population>). Sirindhorn Hospital is located in Prawet district in Eastern Bangkok, and serves the population in Prawet and surrounding districts including Latkrabang, Suan Luang, Nong Chok, Bangna, Saphan Sung and Bangkapi (total population approximately 800,000+). Opened in October 2002, Sirindhorn Hospital has a TB clinic with a pulmonologist, and serves patients with TB with a social security scheme or universal health coverage. Between 2014 and 2019, the hospital treated an average of 197 patients with TB per year, with 73–145 new cases per year. This retrospective study analysed the patient records of adults diagnosed with TB at Sirindhorn Hospital in 2018.

### Definitions

The following definitions will be used throughout this paper ([https://apps.who.int/iris/bitstream/handle/10665/79199/9789241505345\\_eng.pdf](https://apps.who.int/iris/bitstream/handle/10665/79199/9789241505345_eng.pdf)):

**MDR-TB case:** a TB patient with culture-confirmed resistance to isoniazid and rifampicin.

**DR-TB case:** a TB patient with culture-confirmed resistance to one of the first-line drugs, either isoniazid and rifampicin.

**XDR-TB case:** a TB patient with MDR-TB and resistant to a fluoroquinolone and one of the injectable drugs, amikacin, kanamycin or capreomycin

**New case:** a patient with first-time diagnosis of TB.

**Relapsed case:** a patient diagnosed with active TB infection after earlier successful treatment.

**Pulmonary TB:** TB infection confined to the lungs.

**Extrapulmonary TB:** TB infection occurring outside the lungs, such as the pleura, bone, meninges, gastrointestinal tract or lymph nodes.

### Inclusion and exclusion criteria

Records of adult patients (age  $\geq 15$  years) with biologically and/or clinically diagnosed TB (i.e. including X-ray detection, sputum positive, polymerase chain reaction positive and biopsy positive), attending Sirindhorn Hospital in 2018, were included in this study. Patient records from years other than 2018 and from children aged <15 years were excluded.

The patient records were divided into three categories: new cases, relapsed cases, and new cases who contracted TB from a family member with a prior diagnosis of TB.

### Data collection

Data were collected using a data collection form that was designed specifically for this study. The data collection form had three main sections. Section A showed the source of the data, including patient initials, a unique code assigned to the patient, place of residence and patient status (i.e. new case or relapsed case). Section B contained patient details including age, sex, nationality and occupation. Section C contained information on the disease, including type of TB (TB, DR, MDR and XDR), and treatment, including drug resistance. Adverse effects of drugs, compliance and co-infections were also recorded in Section C. Data were entered into Excel (Microsoft Corp., Redmond, WA, USA) for further analysis.

### Data analysis

The prevalence of pulmonary TB in 2018 at Sirindhorn Hospital was calculated for both the Thai and non-Thai populations, and according to the level of resistance (DR-TB, MDR-TB and XDR-TB). Associations between TB and occupation, and comorbidities were also investigated. A logistic regression model was used to calculate adjusted odd ratios to evaluate the relationship between TB and comorbidities (hypertension, HIV), occupation, patient status, age, gender, and town/city of residence. Occupations were categorized into six groups for ease of comparison: students, unemployed, construction, trader, company employee and public transport. Occupations were divided into two groups to assess the association between occupation and disease prevalence: employed (which included all occupation groups except unemployed) and unemployed. Towns/cities were divided into those with high prevalence of TB (Prawet and surrounding districts) and those with low prevalence of TB (other districts) to assess the association between town/city of residence and risk of disease.

Data were analysed using Excel and STATA 17 (Stata Corp., College Station, TX, USA), and measures of central tendency were calculated.

## Results

### Prevalence, diagnosis and distribution of TB among patients at Sirindhorn Hospital in 2018

In total, 186 hospital records were analysed. Of these, 83.3% of cases were diagnosed with pulmonary TB and 17.7% had extrapulmonary TB (Table 1). Age ranged from 16 to 82 years, with mean age of 43 years, median age of 43 years, and standard deviation of 14.7 years. The age distribution of patients with TB was as follows:  $\geq 65$  years ( $n=17$ ), 50–64 years ( $n=44$ ), 31–49 years ( $n=89$ ) and  $\leq 30$  years ( $n=35$ ). Forty-eight percent of the cases were aged 30–49 years, and 67% of cases were aged <50 years (Table 1). Drug resistance was observed in patients with pulmonary TB but not in patients with extrapulmonary TB. Among patients with pulmonary TB, DR-TB, MDR-TB and XDR-TB were observed in 2.72%, 4.1% and 0.68% of cases, respectively. The distribution of

**Table 1**  
Clinical and patient characteristics for patients with tuberculosis (TB) attending Sirindhorn Hospital in 2018.

Measure	Positive cases (total number of cases)	% Prevalence	Total AFB positive (n=155)	Total smear positive (n=153)	Age range, median age (mean)
<b>Pulmonary TB</b>	<b>155 (186)</b>	<b>83.3</b>	<b>106</b>	<b>119</b>	<b>16–82, 44 (44)</b>
Thai patients	141 (155)	90.97	98	110	16–82, 45 (44)
Non-Thai patients	14 (155)	9.03	8	5	19–44, 44 (34)
<b>Drug-resistant TB</b>	<b>4 (155)</b>	<b>2.58</b>	<b>4</b>	<b>3</b>	<b>28–62, 43 (44)</b>
Thai patients	3 (141)	2.84	3	3	
Non-Thai patients	0 (14)	0	0	0	
<b>MDR-TB</b>	<b>5 (155)</b>	<b>3.23</b>	<b>3</b>	<b>4</b>	<b>35–62, 53 (50)</b>
Thai population	4 (141)	2.84	3	3	
Non-Thai population	1 (14)	7.14	1	1	
<b>XDR-TB</b>	<b>1 (155)</b>	<b>0.65</b>	<b>1</b>	<b>1</b>	
Thai population	1 (141)	0.71	0	1	
Non-Thai population	0 (14)	0	0	0	
<b>Extrapulmonary TB</b>	<b>31 (186)</b>	<b>16.67</b>	<b>N/A</b>	<b>N/A</b>	<b>17–68, 35, (38)</b>
Thai population	30 (31)	96.77	N/A	N/A	
Non-Thai population	1 (31)	3.23	N/A	N/A	
<b>Gender</b>					
Male	131 (186)	70.4	123	112	16–82, 43 (44)
Female	55 (186)	29.6	53	42	17–82, 43 (42)
<b>Age distribution, years</b>					
≥65	17 (186)	9.1			
50–64 (n=44)	44 (186)	23.6			
31–49 (n=89)	89 (186)	47.8			
≤30 (n=35),	35 (186)	18.8			

AFB, acid-fast bacillus; MDR, multi-drug-resistant; XDR, extensively drug-resistant.

**Table 2**  
Distribution of patients with tuberculosis (TB) attending Sirindhorn Hospital in 2018 by nationality.

Nationality	Total number of cases	% Pulmonary TB (n)	% Extrapulmonary TB
Thai	71	90.97 (141) DR (4), MDR (4), XDR (1)	96.77 (30)
Myanmar	4	2.58 (4)	0 (0)
Laos	2	1.29 (2)	0 (0)
Philippines	1	0.65 (1) MDR (1)	0 (0)
Cambodia	4	1.94 (3)	3.23 (1)
Non-Thai <sup>a</sup>	4	2.58 (4)	0 (0)
Total	186	100 (155)	100 (31)

DR, mono-drug-resistant TB; MDR, multi-drug-resistant TB; XDR, extensively-drug-resistant TB; n, total number of positive cases.

<sup>a</sup> Nationality not indicated but was identified as non-Thai on the medical records.

cases was skewed, with 70.4% of the cases being male and 29.6% being female (male:female ratio 2.38:1) (Table 1).

Of the 186 patients surveyed, 90.86% (n=169) were new cases and 9.14% (n=17) were relapsed cases. Of the total cases, 5.38% (n=10) were cases contracted from family members. Of the new cases, 70.4% (n=119) were males and 29.6% (n=50) were females. The patient records were also categorized by nationality: 91.94% (n=171) were Thai, 2.15% (n=4) from Myanmar, 1.08% (n=2) from Laos, 0.54% (n=1) from the Philippines and 2.15% (n=4) from Cambodia. Some patient records were entered as non-Thai without a specific nationality; these were grouped separately as ‘non-Thai’ and accounted for 2.15% of cases (Table 2).

*Comorbidities and underlying factors among patients with TB*

Among the patients with TB, 73.66% (n=137) had one or more underlying diseases and 26.34% had no underlying diseases. The most common underlying diseases were hypertension (21.9%, 30/137), diabetes mellitus (19.71%, 27/137), HIV infection (19.71%, 27/137) and dyslipidaemia (13.87%; 19/137) (Table 3).

Ninety-three percent of the TB cases with hypertension (28/30) were new cases. Similarly, 96.3% of TB cases with diabetes mellitus were new

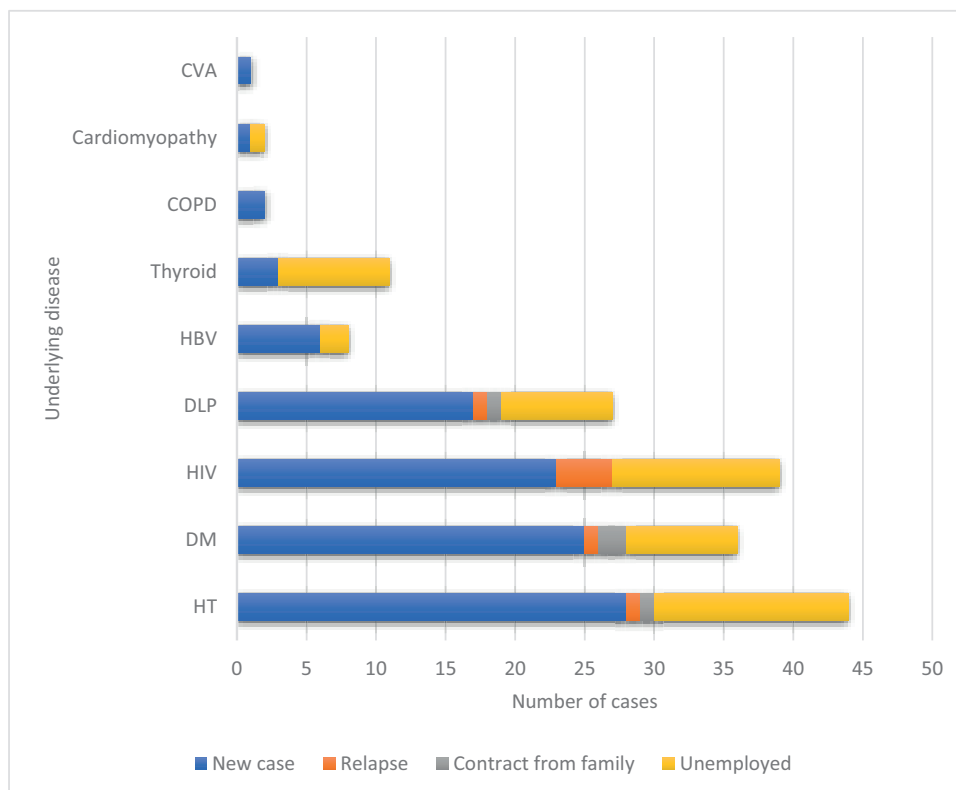
cases. Among all TB cases with HIV infection, 85.2% (23/27) were new cases and 14.8% were relapsed cases. The risk of being HIV positive was 0.92 (95% CI 0.19–4.47) in relapsed cases compared with new cases (Table 4, Figure 1). None of the cases who contracted TB from family members were HIV positive. In total, 15 relapsed cases were recorded, and 46.7% (n=7) had registered comorbidities; of these, 54.71% were HIV positive. Interestingly, none of the MDR-TB patients were HIV positive. Comorbidities were observed more frequently in patients with pulmonary TB compared with patients with extrapulmonary TB. Dyslipidaemia was observed in 10.22% (n=19) of patients, of which 95% (18/19) were new cases. Hepatitis B virus infection was observed in 3.23% (n=6) of patients, and all were new cases (Figure 1).

*TB and drug resistance among new and relapsed cases*

Drug resistance was observed in both males and females aged 35–62 years. Of the 169 patients recorded as new cases in 2018, 95.27% (n=161) were diagnosed with TB with no drug resistance. Drug resistance was observed in 2.37% (n=4) of cases, with MDR-TB registered in 1.18% (n=2) of cases. Among the relapsed cases, 82.35% (14/17) had no drug resistance and 17.65% (3/17) were diagnosed with MDR-TB. None of the MDR-TB cases had any underlying diseases, and 60% of the

**Table 3**  
Leading underlying risk factors in patients with tuberculosis (TB) attending Sirindhorn Hospital in 2018.

Disease	Frequency	Pulmonary TB	Extrapulmonary TB	% Frequency	Age group with highest prevalence, years
Hypertension	30	25	5	21.90	≥65 (64.7%)
Diabetes mellitus	27	26	1	19.71	31–64 (81%)
Human immunodeficiency virus infection	27	21	6	19.71	31–49 (66.67%)
Dyslipidaemia	19	17	2	13.87	
Hepatitis B virus	6	6	0	4.38	
Thyroid disorder	3	2	1	2.19	
Chronic obstructive pulmonary disease	2	2	0	1.46	
Cardiomyopathy	1	1	0	0.73	
Cerebrovascular accident/stroke	1	1	0	0.73	



**Figure 1.** Tuberculosis comorbidities among new and relapsed cases. CVA, cerebrovascular accident; COPD, chronic obstructive pulmonary disease; HBV, hepatitis B virus infection; DLP, dyslipidaemia; HIV, human immunodeficiency virus infection; DM, diabetes mellitus; HT, hypertension.

MDR cases were relapsed cases. The only case with XDR-TB encountered in the study was a relapsed case with no underlying disease.

*Survey of the distribution of TB cases by location*

The distribution of pulmonary and extrapulmonary TB cases by patient occupation was surveyed (Figure 2). Patients with TB reporting at Sirindhorn Hospital in 2018 lived in various zones in Bangkok and other provinces. Prawet reported the highest number of cases (56/186), followed by Latkrabang (23/186) and Suan Luang (19/186), accounting for 30%, 12.4% and 10.2%, respectively (Figure 2). Prawet, Bangna and Nong Chok had cases of pulmonary TB, extrapulmonary TB, and a combination of TB and extrapulmonary TB. Cases of drug-resistant TB were observed in Bangkapi (MDR-TB), Latkrabang (DR-TB and MDR-TB), Nong Chok (MDR-TB), Phraakanong (MDR-TB), Prawet (DR-TB and pre-XDR TB) and Suan Luang (DR-TB) (Figure 2).

*TB and associated risks*

In Prawet, 94.6% (53/56) of cases were new cases, and 34% of these individuals (19/56) were unemployed. Similarly, 67% (4/6) and 37% (7/19) of the total reported cases in Saphan Sung and Suan Luan were

unemployed, respectively. It was observed that 29% of unemployed subjects had hypertension, 20.41% were HIV positive, 16.3% had diabetes mellitus, 16.3% had dyslipidaemia, and 4.16% had hepatitis B virus infection as underlying conditions (Figure 1).

Several associated risks were analysed; none of the findings were statistically significant. Individuals with comorbidities had a 2.16-fold (95% CI 0.33–13.98) higher risk of TB compared with those without comorbidities. In individuals with hypertension, the risk of TB was 1.91-fold (95% CI 0.14–26.61) higher compared with those without hypertension, while those with diabetes mellitus had a 1.04-fold (95% CI 0.09–12.61) higher risk of TB compared with those without diabetes mellitus. In terms of gender, females had a 1.52-fold (95% CI 0.30–7.61) higher risk of TB compared with males. In terms of residence, people living outside Prawet and surrounding districts (Latkrabang, Suan Luang, Bang Kapi, Bang Phli) had a 0.66-fold (95% CI 0.13–3.34) lower risk of TB compared with those living in Prawet and surrounding districts (Table 4A).

In addition to underlying diseases, this study assessed the association between occupation and TB. Unemployed and construction workers represented 26.49% and 11.89% of all TB cases, respectively (Figure 3). The numbers of cases of pulmonary TB, extrapulmonary TB, and both pulmonary and extrapulmonary TB were highest among unemployed in-

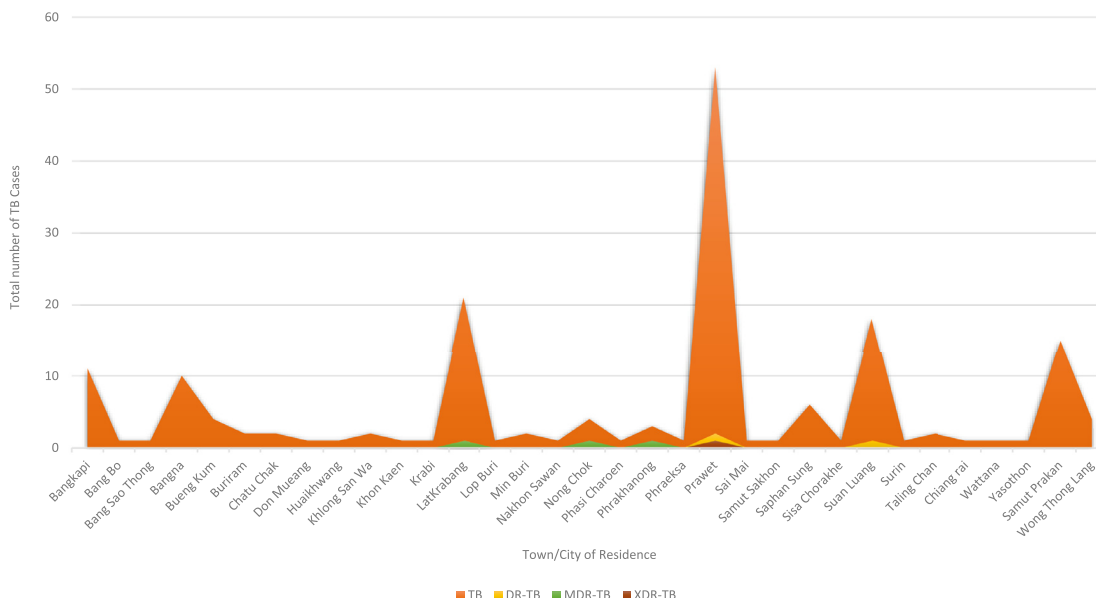


Figure 2. Distribution of tuberculosis (TB) cases by city/town of residence attending Sirindhorn Hospital in 2018. DR-TB, mono-drug-resistant TB; MDR-TB, multi-drug-resistant TB; XDR-TB, extensively-drug-resistant TB.

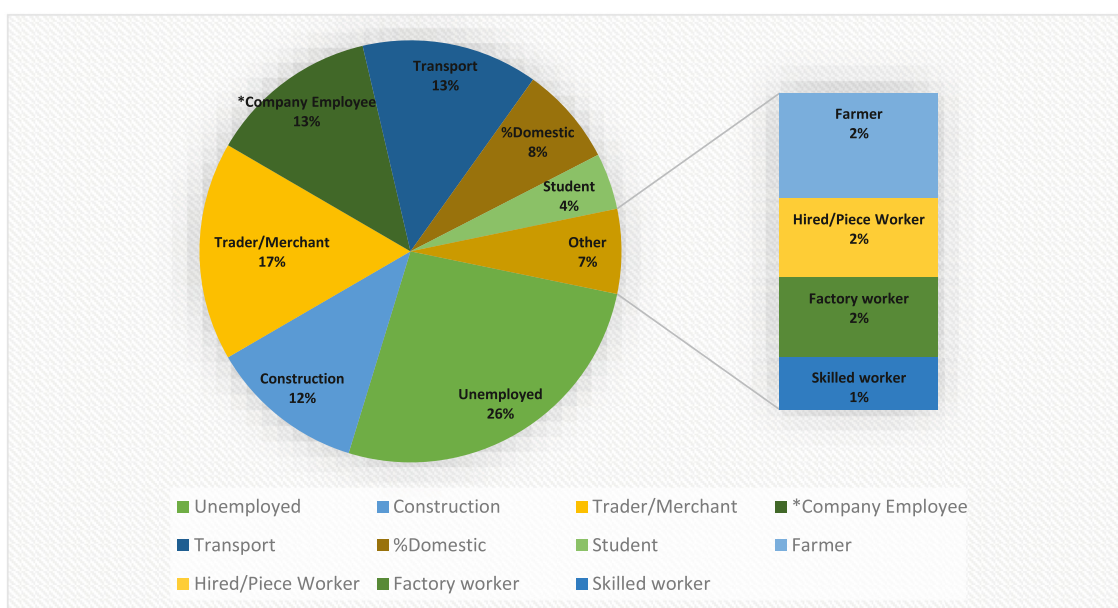


Figure 3. Occupations of tuberculosis (TB) patients attending Sirindhorn Hospital in 2018.

dividuals (26.48%). Using logistic regression, it was observed that there was a 4-fold (95% CI 0.82–19.42) higher risk for an unemployed individual with TB to have hypertension as a comorbidity, a 2.14-fold (95% CI 0.32–10.54) higher risk for a company employee with TB to have hypertension as a comorbidity, and a 1.85-fold (95% CI 0.33–10.53) higher risk for a trader or construction worker with TB to have hypertension as a comorbidity, although the results were not statistically significant. The lowest risks were observed in individuals with TB working in public transport (e.g. taxi drivers, motorcycle taxi drivers) and those doing domestic work (Table 4B). Employed individuals with TB had a 0.595-fold (95% CI 0.22–1.41) lower risk of HIV infection compared with unemployed individuals with TB. The risk of HIV infection was 2.22-fold (95% CI 0.93–5.31) higher in females with TB compared with males, while relapsed TB cases had a 0.92-fold (95% CI 0.19–4.47) lower risk of HIV infection compared with new TB cases (Table 4C).

### Discussion

Globally, approximately 10 million people suffered from TB in 2019, and 44% of these were from the South-East Asia region. Two-thirds of global TB cases were attributed to eight countries: India (26%), Indonesia (8.5%), China (8.4%), Philippines (6.4%), Pakistan (5.7%), Nigeria (4.4%), Bangladesh (3.6%) and South Africa (3.6%) (World Health Organization, 2020). Previous studies have identified migrants as one of the risk groups which could potentially carry latent TB from countries with a high TB burden to countries with a low TB burden (Pareek et al., 2016). In this study, patients of non-Thai origin were considered as migrants. Among the patients with TB attending Sirindhorn Hospital in 2018, non-Thai citizens included individuals from Laos, Cambodia, Myanmar and Philippines. Laos, Cambodia and Myanmar share borders with Thailand, but Philippines does not.

**Table 4A**

Factors associated with adult tuberculosis (TB) patients attending Sirindhorn Hospital in 2018. Multi-variate regression reporting odds ratios for the association of TB (not mono-drug-resistant TB, multi-drug-resistant TB, extensively-drug-resistant TB) and occupation, controlling for age, gender, underlying disease and city/town of residence.

Risk factors		Odds ratio (95% CI)	P-value
Occupation	Unemployed	Reference	
	Employed	0.59 (0.11–3.29)	0.55
Hypertension	No	Reference	
	Yes	1.91 (0.14–26.61)	0.63
Diabetes	No	Reference	
	Yes	1.04 (0.09–12.61)	0.97
Underlying disease	No	Reference	
	Yes	2.16 (0.33–13.98)	0.42
Age		0.96 (1.91–1.01)	0.13
Gender	Male	Reference	
	Female	1.52 (0.30–7.61)	0.63
Town of residence	Prawet and surrounding districts <sup>a</sup>	Reference	0.64
	Other towns <sup>b</sup>	0.66 (0.13–3.34)	0.61

CI, confidence interval.

<sup>a</sup> Prawet, Latkrabang, Suan Luang, Bang Kap and Bang Phli.

<sup>b</sup> Other districts in Bangkok and outside Bangkok.

**Table 4B**

Multi-variate regression reporting odds ratios for the association between hypertension and occupation, controlling for age, gender and city/town of residence.

Occupation	Odds ratio (95% CI)	P-value
Student	Reference	
Unemployed	4.00 (0.82–19.42)	0.09
Construction <sup>a</sup>	1.05 (0.13–8.24)	0.96
Trader <sup>b</sup>	1.85 (0.33–10.53)	0.49
Company employee <sup>c</sup>	2.14 (0.32–10.54)	0.44
Public transport <sup>d</sup>	0.74 (0.10–5.71)	0.77
Domestic <sup>e</sup>	0.71 (0.06–8.66)	0.79

CI, confidence interval.

<sup>a</sup> Welder and building contractor, construction worker.

<sup>b</sup> Merchant, trader, grocery, sell furniture, sales person, sell auto parts, fish seller, dress maker (tailor), beef seller, vendor, property for sale, delivery person, fruit seller, merchant (seller at home), factory owner (charcoal), sales person (in store), sales person (market), trader (construction material trade), trader (business owner sells clothes), trader (sell clothes), meat seller, merchant (seller in market).

<sup>c</sup> Company employee, restaurant staff, security guard, teacher, soldier, office worker, retired government official, official staff in State Railway of Thailand, government official, office worker, retired government official, state enterprise employee.

<sup>d</sup> Taxi driver, motorcycle taxi driver, driver in a company, driver, official driver, guard in pub.

<sup>e</sup> Housewife, housemaid, self-employed, gardener, maid, housewife, hired worker (packs paper bags at a house).

Cases of pulmonary TB were higher in males compared with females, which is consistent with observations globally. The global tuberculosis report 2020 and surveys conducted in over 15 countries in Asia reported that adult males (age ≥15 years) accounted for >50% of those who developed TB in 2019, with 66–75% of prevalent cases observed occurring in men (Strasser, 2003; Onozaki et al., 2015; World Health Organization, 2020). In the current study, 47.85% of patients were aged 31–49 years. The study was conducted at a single hospital in Bangkok, so the results reported here only represent adult TB cases at this hospital in 2018.

More TB cases were observed among Thai nationals compared with non-Thai migrants; this could be attributed to the composition of the population living around Prawet where the hospital is located, as well

**Table 4C**

Multi-variate regression reporting odds ratios for the association between human immunodeficiency virus infection and occupation, controlling for patient status, age, gender and town of residence.

Risk factors		Odds ratio (95% CI)	P-value
Occupation	Unemployed	Reference	
	Employed	0.595 (0.22–1.41)	0.21
Patient status	New case	Reference	
	Relapsed case	0.92 (0.19–4.47)	0.92
Age		0.99 (0.96–1.02)	0.61
Gender	Male	Reference	
	Female	2.22 (0.93–5.31)	0.07
Town of residence	Other districts <sup>a</sup>	Reference	
	Prawet and surrounding districts <sup>b</sup>	0.72 (0.28–1.82)	0.49

CI, confidence interval.

<sup>a</sup> Prawet, Latkrabang, Suan Luang, Bang Kapi and Bang Phli.

<sup>b</sup> Other districts in Bangkok and outside Bangkok.

as the number of foreign nationals that attend Sirindhorn Hospital with a social security scheme or universal health coverage. Drug resistance was observed in both Thai and non-Thai patients, DR-TB cases (RR-TB or isoniazid-resistant TB), MDR-TB and XDR-TB cases aged 32–65 years. Globally, >200,000 people were reported to have RR-TB/MDR-TB, with the number of people tested for rifampicin resistance increasing to 61% in 2019, compared with 51% in 2017 and 7% in 2012 (World Health Organization, 2020). The trend of drug resistance at Sirindhorn Hospital is yet to be determined as this study only focused on patient records from a single year. In June 2021, Thailand was removed from the WHO list of 30 high MDR-/XDR-TB burden countries globally. The data in this study were collected in 2018 before this revision was implemented.

Among the MDR-TB cases, one of the non-Thai patients, a teacher, was resistant to rifampicin and isoniazid and had to be sent back to their home country for further management and treatment. The teacher had been working in Thailand for 3 years before diagnosis. The patient was treated for pulmonary TB (smear positive) in 2005 and was treated successfully but relapsed in 2018 with MDR-TB. Despite the lack of data on whether any of the students or close contacts caught TB, this case highlights the possible risks that occupations could have in the spread of infectious diseases such as TB. It was also observed that among the Thai MDR-TB patients, two were relapsed cases (10 years and 2 years after initial diagnosis and treatment, respectively), while the other two were new cases. Of the two relapsed cases, one was unemployed and the other was a company employee; both were resistant to rifampicin and isoniazid. All three relapsed MDR-TB cases had no reported underlying conditions. The cause of relapse was unknown, and the possibility of re-infection with a drug-resistant TB strain cannot be excluded. Neither of the two new cases, both traders by occupation, had underlying disease conditions. One new case was resistant to isoniazid, rifampicin and ethambutanol, and the other new case was resistant to isoniazid, rifampicin, ethambutanol and streptomycin. The latter succumbed to the disease. It is important to note that not all relapsed patients had MDR-TB, but 57.14% of relapsed patients with comorbidities were HIV positive which is one of the risk factors for MDR-TB and XDR-TB (Dean et al., 2014; Singh et al., 2020; Sultana et al., 2021). Although the results presented in this study may not show an association between HIV infection and MDR-TB or XDR-TB, other studies have reported associations between HIV and drug resistance (Singh et al., 2020). The results observed in this study are in line with other studies which reported that, among the WHO regions, South-East Asia exhibits the highest risk of MDR-TB in HIV-positive patients, with a pooled odds ratio 1.86 times higher in HIV-positive patients compared with HIV-negative patients (Sultana et al., 2021).

The time range between cure and relapse was 1.5–32 years in the 15 relapsed patients reported in this study. Among the new TB cases recorded in 2018, 5.4% contracted TB from a family member, and some

of these were family members who had active TB as far back as 10 years prior to the diagnosed cases. Among the relapsed patients, one patient was diagnosed with pre-XDR; this patient was resistant to isoniazid, rifampicin, streptomycin and fluoroquinolone. The patient had completed treatment in 2015 but relapsed in 2018 and had no underlying diseases. It is interesting to note that the cases of MDR-TB and pre-XDR-TB reported in this study had no reported underlying conditions. Understanding the association between relapse and underlying conditions would be of interest.

Despite the fact that the MDR-TB and XDR-TB patients in this study did not have any reported underlying conditions, some of the TB cases had underlying conditions, with diabetes mellitus and hypertension being the most frequently recorded comorbidities. Diabetes mellitus and hypertension have been reported elsewhere as underlying comorbidities in patients with TB (Aungkulanon et al., 2017). It is estimated that the prevalence of diabetes in Thailand is 9.9% in adults aged  $\geq 20$  years (Jitmuang et al., 2015; Aekplakorn et al., 2018). In the present study, diabetes mellitus was found to be the second most common comorbidity among patients with TB; hypertension was the most common comorbidity.

Apart from comorbidities associated with TB, this study investigated the area of residence and occupation for each of the TB cases from Sirindhorn Hospital in 2018. High numbers of TB cases were observed in Prawet, followed by Latkrabang, Suan Luang and Samut Prakan. This could be attributed to the proximity of these residential towns to the hospital. Interestingly, among the various occupations that the patients reported during the study, unemployed cases had a higher prevalence of TB compared with employed cases or traders. The most commonly occurring comorbidities among unemployed cases were hypertension, HIV infection, diabetes mellitus, dyslipidaemia and thyroid disorders. The fact that hypertension was the most common comorbidity could be linked to the stresses associated with unemployment and associated socio-economic factors. Singasalasang et al. reported that residential area and region were significantly associated with hypertension; individuals with a low income, low educational status and living in Bangkok were vulnerable to hypertension (Singasalasang et al., 2017). Similarly, the high prevalence of HIV infection among this group may indicate lifestyle and/or associated behaviours that could put people in this category at risk of contracting the virus. Both diabetes mellitus and dyslipidaemia could be associated with predisposed conditions and/or lifestyle, such as dietary conditions that may put this group at risk of these diseases. Further studies are required to establish if there is any association between unemployment and comorbidities, including hypertension and diabetes mellitus. Although this study did not investigate mortality rates, other studies have reported high mortality rates in populations with livelihoods highly dependent on agriculture (Aungkulanon et al., 2012, 2017). In this study, it was not clear whether those who registered as unemployed were involved in agriculture. However, it is of interest to understand why there is a high prevalence of TB among unemployed individuals, and identify the drivers leading to this observation. The socio-economic status of the unemployed individuals was not known; as such, an influence of socio-economic status on the high TB burden observed in Prawet cannot be excluded (Aungkulanon et al., 2017).

#### Limitations of the study

This study used data from a single hospital and from a single year thus limiting understanding of trends in previous years, as well as in other hospitals. As this research was run as a pilot study, exploring trends of TB cases from previous years and including data from other hospitals is recommended. Further studies on the association between occupation and TB status are also recommended.

#### Conclusion

This study has shown that occupation could play a role in the prevalence of TB among communities. The highest prevalence of TB was observed among unemployed individuals, with unemployed TB patients having increased risk of hypertension as a comorbidity. MDR-TB and XDR-TB cases in this study had no underlying conditions; while some of the relapsed patients had MDR-TB, this was not the case for all relapsed patients. Mapping the zones/areas of residence for TB cases could assist in identifying TB hot spots, and could improve understanding of the drivers of the high TB burden and associated socio-economic factors. Multi-centre studies are required to further investigate the outcomes reported in this pilot study.

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#### Conflict of interest statement

None declared.

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#### Ethical approval

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#### Author contributions

FMN: Project idea and formulation, proposal writing and ethical application, data analysis and visualization, manuscript writing and compilation.

PP: Proposal editing and translation, ethical application and manuscript editing.

MP: Data collection.

AK: Data collection.

KR: Data collection.

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