Spatial variation of tuberculosis risk in Indonesia 2010-2019

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Tities Puspita[1], Anton Suryatma[1], Oster Suriani Simarmata[1], Ginoga Veridona[1], Heny Lestary[1], Athena Anwar[1], Imran Pambudi[2], Sulistyo[3], Tiffany Tiara Pakasi[3]

[1]Centre for Research and Development of Public Health Efforts, National Institute of Health Research and Development, Ministry of Health, Indonesia
[2]Directorate of Health Surveillance and Quarantine, DG of Disease Prevention and Control, Ministry of Health, Indonesia
[3]Directorate of Direct Communicable Disease Prevention and Control, DG of Disease Prevention and Control, Ministry of Health, Indonesia

Corresponding author: Tities Puspita
Email: tiespuspita@gmail.com

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Abstract

Background: As the second-highest country in tuberculosis (TB) cases globally, Indonesia has experienced an increasing trend of notification rate in the last ten years; however, the 34 provinces may have different risks. This study aims to examine TB risk variation across Indonesia in 2010-2019**.**

Methods: A descriptive analysis was conducted on TB routine data of 2010-2019 from the Ministry of Health. Cases included all types of TB patients. Total cases, incidence rate (IR), and standardized morbidity ratio (SMR) were calculated for each province and national level during the period. Distributions of IRs and SMRs were displayed on maps.

Results: During 2010-2019, 3,866,447 TB cases occurred in Indonesia, and the national IR was 1,523 per 100,000 populations. The highest proportion of cases and IR were in West Java (20.6%, 314 per 100,000); while the lowest were in North Kalimantan (0.2%, 3 per 100,000). Higher risks of TB occurred in DKI Jakarta (SMR 1.9), Papua (1.7), North Sulawesi (1.7), Maluku (1.5) and West Papua (1.5) among others. The smallest SMRs were found in Bali and Yogyakarta (0.5).

Conclusion: TB risk varied across Indonesia in 2010-2019, with a higher risk in DKI Jakarta and several provinces in eastern Indonesia. Given the underreporting nature of routine data, ~~a~~ validation is required when using the finding of this study in the local-level intervention. ***(Health Science Journal of Indonesia 2021;12(2):104-10)***

Keywords: tuberculosis, TB, standardized morbidity ratio, spatial variation, risk

Abstrak

Latar belakang: *Sebagai negara dengan jumlah kasus tuberkulosis (TB) terbesar kedua di dunia, Indonesia menunjukkan tren peningkatan notification rate di sepuluh tahun terakhir. Akan tetapi, risiko TB di 34 provinsi bisa saja berbeda-beda. Artikel ini bertujuan mengkaji variasi risiko TB di Indonesia pada tahun 2010-2019.*

Metode: *Data rutin TB tahun 2010-2019 dari Kementerian Kesehatan dianalisis secara deskriptif. Kasus TB didefinisikan sebagai semua tipe pasien TB. Total jumlah kasus, incidence rate (IR), dan standardized morbidity ratio (SMR) dihitung untuk tiap provinsi dan tingkat nasional selama periode tersebut. Sebaran IR dan SMR diplot di atas peta.*

Hasil: *Selama 2010-2019, terdapat 3.866.447 kasus TB dan IR nasional 1.523 per 100.000 populasi. Proporsi kasus dan IR terbesar ada di Jawa Barat (20,6%, 314 per 100.000) dan terkecil di Kalimantan Utara (0,2%, 3 per 100.000). Risiko TB lebih tinggi di antaranya terjadi di DKI Jakarta (SMR 1,9), Papua (1,7), Sulawesi Utara (1,7), Maluku (1,5) dan Papua Barat (1,5). Standardized Morbidity Ratio terendah ditemukan di Bali dan Yogyakarta (0,5).*

Kesimpulan: *Dapat disimpulkan bahwa risiko TB beragam di seluruh Indonesia selama 2010-2019, di mana DKI Jakarta dan beberapa provinsi di timur Indonesia memiliki risiko lebih tinggi. Mengingat adanya kurang lapor dalam data rutin, validasi diperlukan jika menggunakan temuan studi ini dalam intervensi di tingkat lokal.* ***(Health Science Journal of Indonesia 2021;12(2):104-10)***

Kata kunci: *tuberkulosis, TB, standardized morbidity ratio, variasi spasial, risiko*

Tuberculosis (TB) is in second place after HIV as a major infectious disease in the world. In 2015, there were 10.1 million total TB prevalence cases and 1.3 million TB deaths.[1] It is estimated that around 10 million people had tuberculosis (TB) in 2019. More than half were men aged 15, followed by women (32%) and children (12%). Death due to TB is estimated at 1.2 million people in 2019.[2] The regions with the most TB cases in 2019 were Southeast Asia (44%), Africa (25%), Western Pacific (18%) and the rest in the Eastern Mediterranean, Americas and Europe. Two-thirds of the world's TB burden is located in eight countries, or so-called high TB burden countries (HBC). Indonesia (8.5%) is in second place after India (26%) and before China (8.4%).[2]

In Indonesia, TB is also a national health problem. The 2013-2014 national TB prevalence survey reported that pulmonary TB confirmed by bacteriological methods was 759 per 100,000 population aged 15 years (95% CI 589-961). The burden of TB disease is higher in men, increasing with age and more in urban areas.[3] The prevalence of the Indonesian population diagnosed with pulmonary TB by a general practitioner or specialist in the last 1 year maximum is 0.42% according to the results of the 2018 Basic Health Research (Riskesdas).[4] Through the National TB Control Program, Indonesia has a target of TB elimination in 2035 and Indonesia free of TB in 2050. It is said that TB is eliminated if the number of TB cases is 1 per 1,000,000 populations.[5]

Standardized morbidity ratio (SMR) is defined as the ratio of observed cases in a study population to expected cases in that population.[6] It can be used as one of the epidemiology measures other than incidence, prevalence, odds ratio, relative risk, attributable risk and the likes. The SMR is a ratio where the denominator is the expected cases calculated based on the multiplication of the rates in a general population with the number of a study population. It has not been widely used in Indonesia as a measure of disease frequency yet. As a product of indirect standardization by incorporating the number of population in specific areas, the SMR is more objective to examine the disease distribution spatially.

TB risk shows variations across the spatial landscapes, even within one country. A study in Ethiopia reported that multidrug resistant tuberculosis (MDR-TB) cases were clustered around the border regions of Ethiopia-Sudan and Ethiopia-Eritrea, where many seasonal migrants resided.[7] Moreover, Diah et al (2017) reported that among eleven districts in Kedah State, Malaysia, the highest risk of TB occurred in Kota Setar, while the lowest in Kulim.[8]

There is an increasing trend in notification rates in Indonesia according to the 2020 Global TB Report.[2] However, the risk of TB in 34 provinces may vary. Literatures reporting TB risk variation across different geographical areas in Indonesia in a long time span are still limited. The purpose of this study is to examine the spatial variation of TB risk in Indonesia during the 2010-2019 periods.

METHODS

It is a descriptive analysis of annual TB case data in Indonesia for the 2010-2019 periods. The unit of analysis is provincial level.

Data Source

The number of TB cases was obtained from routine data collected every three months by the Ministry of Health. Tuberculosis cases were defined as new and relapsed patients of either pulmonary or extra pulmonary TB. Data for 2011-2016 are district/city level data, while 2017-2019 are individual cases originating from the Tuberculosis Information System (*Sistem Informasi Tuberkulosis, SITB*). Total cases for provincial and national levels for ten years were calculated from these two sources. The population data were obtained from supporting data in routine program data and population projections by the Central Statistics Agency (*BPS*) (https://sensus.bps.go.id/topik/tabular/sp2020/83/175748/0).

Incidence rate (IR)

The national incidence rate of TB was obtained by dividing the total number of national cases during 2010-2019 by the median of Indonesian population in the same period. A similar calculation was used to compute the IR for each province.

Standardized morbidity ratio (SMR)

The difference of TB cases observed in a province with the expected TB cases if that province has the same rate with the national level during 2010-2019 was identified with standardized morbidity ratio (SMR)[9] following the formula as follow:

$$Yi = [Oi/Ei]$$

Y is the SMR in province *i*, *O* is the number of TB cases occurring in that province, and *E* is the number of TB cases expected to occur in that province over a ten-year period. The expected number of TB cases (*E*) is calculated by multiplying the median population of each province by the crude national TB IR.[7] An SMR >1 means the risk of TB in a province is greater than in the national population because there are more TB cases in the province than anticipated based on the national IR. If an SMR <1, it indicates a lower TB risk than the national level; and an SMR equals to 1 means the TB risk in the province is the same as the national population.[9] The IR and SMR distributions of 34 provinces were then mapped in choropleth maps created in QGIS 3.16.5.

RESULTS

At the national level, there were 3,866,447 TB cases, with an average of 386,645 cases per year during 2010-2019 (Table 1). The largest proportion of cases by province was in West Java (20.6%) and the smallest in North Kalimantan (0.2%). The national IR during the study period was 1,523 per 100,000 populations. West Java and North Kalimantan have the highest and lowest IRs, 314 and 3 per 100,000 populations, respectively. The majority of provinces with high IR were located in Java Island, and North Sumatera as well as South Sulawesi (Figure 1).

The distribution of SMR of TB in ten year period across Indonesia was shown in Figure 2. According to the SMR, several provinces were identified as having greater TB risk compared to the national risk. The risk of TB is higher in DKI Jakarta (SMR = 1.9), Papua (SMR = 1.7), North Sulawesi (SMR = 1.7), Maluku (SMR = 1.5) and West Papua (SMR = 1.5) among others; while the lowest SMRs were found in Bali and Yogyakarta (SMR = 0.5) (Figure 2)

Table 1. Distribution of observed and expected cases, proportion, incidence rate, and SMR of TB by province in Indonesia, 2010-2019

No	Province	Population (median)	Observed cases	% cases	IR (per 100K)	Expected cases	SMR
1	Aceh	4,875,203	59,662	1.5%	24	74,254	0.8
2	North Sumatera	14,005,850	242,786	6.3%	96	213,321	1.1
3	West Sumatera	5,149,845	80,029	2.1%	32	78,437	1.0
4	Riau	6,357,668	70,187	1.8%	28	96,833	0.7
5	Riau Islands	2,007,348	35,674	0.9%	14	30,574	1.2
6	Jambi	3,408,180	38,433	1.0%	15	51,910	0.7
7	South Sumatera	8,029,618	119,201	3.1%	47	122,298	1.0
8	Bangka Belitung	1,377,031	17,088	0.4%	7	20,973	0.8
9	Bengkulu	1,852,096	23,203	0.6%	9	28,209	0.8
10	Lampung	8,047,623	97,806	2.5%	39	122,572	0.8
11	Banten	11,900,844	181,861	4.7%	72	181,260	1.0
12	DKI Jakarta	10,157,015	291,505	7.5%	115	154,700	1.9
13	West Jawa	46,552,872	797,082	20.6%	314	709,040	1.1
14	Central Jawa	33,731,500	436,957	11.3%	172	513,760	0.9
15	DI Yogyakarta	3,648,850	30,049	0.8%	12	55,575	0.5
16	East Jawa	38,656,890	486,858	12.6%	192	588,778	0.8
17	Bali	4,175,400	32,457	0.8%	13	63,595	0.5
18	West NT	4,775,000	61,668	1.6%	24	72,727	0.8
19	East NT	5,098,423	63,040	1.6%	25	77,653	0.8
20	West Kalimantan	4,693,750	61,954	1.6%	24	71,490	0.9
21	Central Kalimantan	2,432,977	28,398	0.7%	11	37,056	0.8
22	South Kalimantan	3,952,304	59,825	1.5%	24	60,197	1.0
23	East Kalimantan	3,463,150	51,822	1.3%	20	52,747	1.0
24	North Kalimantan	670,000	6,960	0.2%	3	10,205	0.7

No	Province	Population (median)	Observed cases	% cases	IR (per 100K)	Expected cases	SMR
25	North Sulawesi	2,396,321	61,421	1.6%	24	36,498	1.7
26	Gorontalo	1,134,049	22,694	0.6%	9	17,273	1.3
27	Central Sulawesi	2,858,645	41,565	1.1%	16	43,540	1.0
28	South Sulawesi	8,458,274	147,833	3.8%	58	128,827	1.1
29	West Sulawesi	1,283,160	17,441	0.5%	7	19,544	0.9
30	Southeast Sulawesi	2,460,331	40,911	1.1%	16	37,473	1.1
31	Maluku	1,699,245	39,489	1.0%	16	25,881	1.5
32	North Maluku	1,154,331	17,052	0.4%	7	17,581	1.0
33	Papua	3,178,600	83,179	2.2%	33	48,413	1.7
34	West Papua	876,719	20,357	0.5%	8	13,353	1.5
	Indonesia	253,856,079	3,866,447	100.0%	1.523	3,866,447	1.0

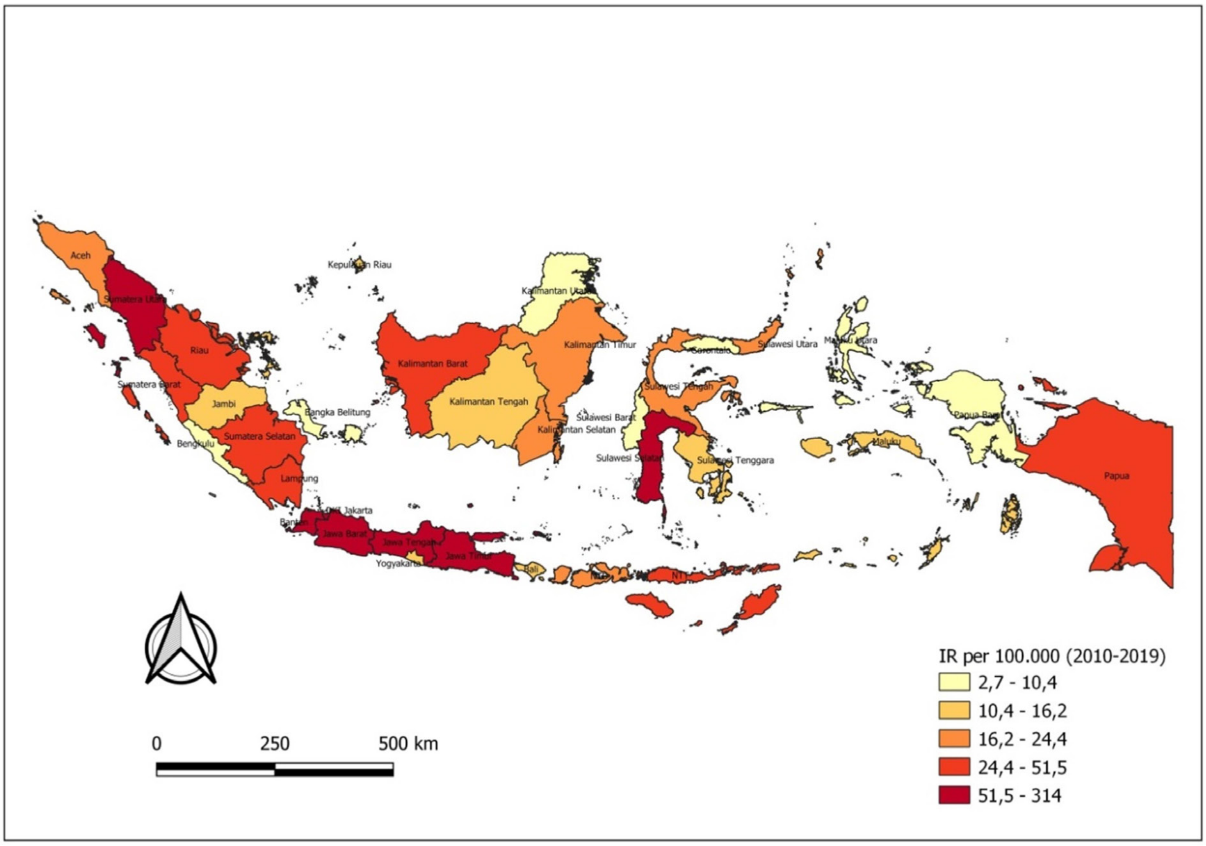

Figure 1. Distribution of TB incidence rate (IR) in Indonesia, 2010-2019

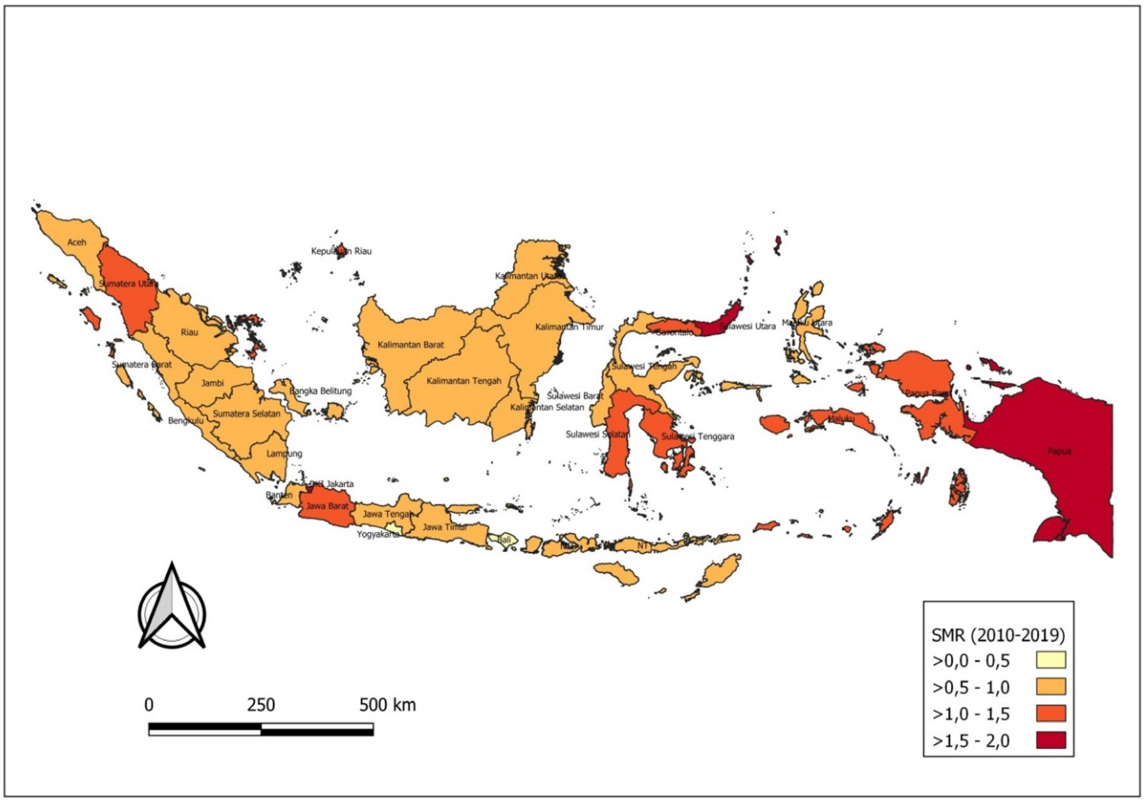

Figure 2. Distribution of SMR of TB in Indonesia, 2010-2019

DISCUSSIONS

This study shows that the risk of TB varies among Indonesia's 34 provinces during the 2010-2019 periods. It means there have been disparities in TB burden across the country, which can be related to aspects, such as health, environment, and socioeconomic.

Several factors can explain the differences in TB risk. Low socioeconomic groups have a greater risk of developing TB due to unhealthy housing environments, for example, overcrowding, lack of ventilation, and lack of safe cooking fuel facilities. They also tend to be malnourished and consume alcohol.[10] These groups include marginalized populations such as prisoners, who, while living in cramped cells, are also vulnerable to HIV coinfection and to the use of unsafe injecting needles for drugs.[10] Ethnic differences also correlate with TB risk, with indigenous groups or foreign-born immigrants having a higher risk.[10,11] This is related to socio-economic factors as well as genetic factors.[10,12,13] In addition, the health system can also play a role; for example, web-based reporting can increase TB notifications or delays in diagnosis or treatment will affect the TB infection rate at the household level.[10] In terms of the environment, climatic factors, such as air temperature, humidity, and duration of sunlight affect the incidence of TB in an area.[14,15]

The high number of excess TB cases in DKI Jakarta can be attributed to urban characteristics. Based on the 2013-2014 Tuberculosis Prevalence Survey, the prevalence of TB in urban areas was higher than that in rural areas. One possible explanation is the in-house density is higher in the cities rather than in the villages. It is also supported by the finding of a study by the Ministry of Health, which showed that more TB cases were found in residences with housing density less than 8m^2/person.[3] Another possibility is that case finding and reporting in DKI Jakarta were more intensive which lead to higher SMR. In this study, the cases reported in the province were almost twice as high as the cases anticipated by TB program coverage. This may support the notion that SMR can be utilized to compare the actual TB program's performances (observed cases) with the program's target (expected cases).

The higher risk of TB in Papua Province can be attributable to HIV coinfection. The province is one of the areas with the greatest number of cumulative

HIV cases until 2020.[16] Regions with a high burden of TB generally also have a high prevalence of HIV, especially among young men and women. At the individual level, the number of TB cases is quite high among HIV patients. Sociodemographic and clinical factors may influence TB risk in people with HIV in areas with a high TB prevalence.[17] Similarly, one study showed that HIV coinfection among TB patients was higher in Merauke General Local Hospital, Papua, than in other study areas in Indonesia.[18]

Bali and DIY were among the lower TB-risk provinces, and it may be linked to less intensive case finding and reporting. In that sense, the coverage of TB programs to diagnose cases in the population and notify them into the available TB surveillance system is less than what the program had targeted.

The disparity of TB burden has also been reported in global literatures. A research in China stated that TB incidence occurred more frequently in the northwestern and southern provinces[19], and spatiotemporal TB clusters appear in several provinces at different times.[20] Other studies also found that provinces located in central and eastern Iran had TB clusters with the highest rates in Khuzestan Province[21];and TB notification rates varied by geographic region in India.[22] These studies showed that disparities in TB risks within a country is not exclusive to Indonesia alone.

In disease mapping, SMR is useful to identify high risk areas. The Standardized Morbidity Ratio is a conventional method for estimating relative risk[8] and is calculated through an indirect standardization process. As a product of standardization, SMR is more appropriate for comparing health status between populations because the difference in the population structures (e.g. age groups and sex) has been controlled. It is different from using crude rates for comparison, which will lead to wrong conclusions when the populations being compared have different compositional characteristics. However, the SMR value is a hypothetical value, which means the ratio does not describe actual morbidity in a population and should not be used as a substitute for crude rates when assessing disease burden in that population. In addition, SMR cannot be used to compare among many populations and can only be used to compare each population with one standard.[9,23] Despite its easy application, SMR has not been widely used in the Indonesian literature, but already in literatures from other countries, for example Malaysia[8] and Ethiopia.[7] In the latter study, once the high and low risk areas were recognized with the SMR, the underlying factors were examined.

This study has several limitations. The use of routine data has the potential of underreporting because the incoming data only come from patients or people accessing health facilities, so that the estimated TB risk may not reflect the actual conditions in that area. In addition, this study has not explored the relations between several known TB risk factors, including indoor pollution, smoking behavior, diabetes, HIV, socioeconomic level, and climate.[10,14,15,24,25]

In conclusion, TB risk varied across Indonesian provinces during 2010-2019. Provinces with higher TB risk compared to the national risk were DKI Jakarta and Papua; while Bali and DI Yogyakarta were among the lower risk provinces. Given the underreporting nature of routine data, validation is required when using the finding of this study in the local-level intervention.

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Author contribution

Main contributors: TP, AS. Conceptualization: TP, AS. Data curation: TP, AS, OSS, HL, IP, Sul, TTP. Formal analysis: AS, TP. Funding acquisition: AA. Methodology: TP, AS. Visualization: GV, Writing – original draft: TP, AS. Writing – review and editing: TP, AS, OSS, AA, HL, Sul, TPP, IP.

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