Spasial Temporal TB

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Title of the article: The Spatial-Temporal Dynamics of Tuberculosis Clusters in Indonesia

Introduction

Tuberculosis (TB) is strongly correlated with low social determinants, such as education, occupation, income as well as social class. Previous reviews have stated that low social determinants directly, or through risk factors (i.e. poor housing conditions, poor food security and poor healthcare access), influence the risk of contracting TB. [1,2] Research on TB and social determinants has also reported similar findings, including studies conducted in Indonesia, which found that low social determinants, poor housing conditions and poor food security were correlated with TB transmission, TB incidence and sputum conversion delay. [3–5] These findings reinforce the need to provide social protections, alleviate poverty and address other determinants of TB under the policy and system of a TB control program. [1,2,6]

Furthermore, stratification of social determinants leads to clustering of low social determinant communities. [1,2] Due to their condition, TB patients tend to be clustered in low socio-economic communities. Clustering refers to the significant aggregation of disease events based on spatial and/or temporal parameters (space-time). This includes information, such as cluster location, cluster size and the number of disease cases inside the cluster. [7] Studies conducted in Vittoria, Brazil, Antananarivo, Madagascar, Bandar Lampung, Indonesia and Hermosillo, Mexico, have reported that clustered TB incidences are located in low social determinant areas. [8–11]

Significant TB clusters based on time and location (spatial-temporal TB) provide information about where vulnerable people live; they also provide an indication of the characteristics of those communities. The information is very useful in supporting a TB control program, especially for focusing on interventions to address the determinants and the intervention area. [8–13] Therefore, the information should be provided continuously in order to identify whether there are dynamics associated with the location, size and number of cases in the cluster. However, only a few studies have investigated the dynamics of spatial-temporal TB clusters.

The present study investigated the dynamics of spatial-temporal TB clusters in Bandar Lampung, Indonesia in 2015 and 2016, and it identified the characteristics of

the social determinants of the clusters. In this research, the social determinants were represented by indicators of population density and the percentage of poverty in the studied clusters.

Subjects and Methods

A cross-sectional study was performed to investigate the dynamics of the spatial-temporal TB clusters in Bandar Lampung in 2015 and 2016. The study population included all smear positive TB patients that were registered at all 30 community health centers that had implemented a Directly Observed Treatment Short Course (DOTS) strategy during the study time period. The sample included all study population with an accurate address, who had not moved to another place and who were still alive.

Variables in this study consisted of the geographical coordinates of the residences of the sample and the social determinant indicators (sub-district population density and percentage of poverty). The population density is the sub-district total population divided by the area in kilometers square (km^2) (low density: <2,500 persons/ km^2, middle density: 2,501–7,500 persons/km^2 and high density: >7,501 person/ km^2). [14] In the present study, the percentage of poverty in the sub-district poverty was classified into three levels, based on the Human Poverty Index of the United Nation Development Program (UNDP): low (<5%), middle(5–10%) and high (10%). [15] The social determinant data were obtained from the secondary data for each sub-district population. The geographical coordinates of the study sample's residences were obtained using Geographical Positioning System (GPS) tools. They were then analyzed with the space-time permutation model using SaTScan software to identify the spatial-temporal TB cluster. [16,17] In the present study, the spatial-temporal cluster time aggregation was three months. This time aggregation was based on the consideration that, after two months of treatment, smear positive TB patients would have sputum conversion, and there was a 14-day delay before new TB patients in Indonesia would receive treatment. [18,19] The spatial-temporal clusters were then overlaid with the sub-district population density and percentage of poverty data. The results were visualized using the Geographical Information System (GIS) program.

This research received ethical approval from the Faculty of Medicine, University of Lampung. The respondents also provided informed consent; their participation was voluntary.

Results

In 2015, the eligible samples consisted of 705 smear positive TB patients. In 2016, the eligible samples consisted of 1,134 smear positive TB patients. The analysis results showed that, in 2015, there were three TB spatial-temporal clusters. The first (the most likely) cluster was in the sub-districts of Tanjung Karang Timur, Way Halim, Labuhan Ratu and Sukarame (coordinate centre at latitude -5.38289, longitude 105.281088 with a 4.40 km radius; p=0.000021). There were 94 TB cases in that cluster. The second cluster (secondary cluster 2) was located in the sub-districts of Teluk Betung and Bumi Waras (coordinate centre at latitude -5.445093, longitude 105.272562 with a 2.21 km radius; p=0.0021). There were 184 TB cases in that cluster. The third cluster (secondary cluster 3) was located in the Teluk Betung Utara sub-district (coordinate centre at latitude -5.425175, longitude 105.276625 with a 0.26 km radius; p=0.974). There were seven TB cases in that cluster. The most significant spatial-temporal clusters were the first (most likely) cluster and the secondary cluster 2. All three clusters are shown in Figure 1. A brief overview of the SaTScan analysis results is presented in Table 1.

In 2016, there were also three TB spatial-temporal clusters. The first (most likely) cluster was located in the Kemiling sub-district (coordinate centre at latitude -5.391621, longitude 105.264814 with a 1.98 km radius; p=0.0025). There were 15 TB cases in that district. The second cluster (secondary cluster 2) was located in the Tanjung Karang Timur sub-district (coordinate centre at latitude -5.408078, longitude 105.264814 with a 0.50 km radius; p=0.286). There were 13 TB cases in that cluster. The third cluster (secondary cluster 3) was located in the Kedaton, Way Halim, Rajabasa and Labuhan Ratu sub-districts (coordinate centre at latitude -5.371937, longitude 105.251907 with a 3.72 km radius; p=0.450). There were 166 TB cases in that cluster. The only significant spatial-temporal cluster was the first (most likely) cluster. All three clusters are shown in Figure 2. A summary of the SaTScan analysis results is presented in Table 2.

The spatial-temporal TB clusters in 2015 and 2016 were then overlaid with the population density in 2015 and 2016, as illustrated in Figure 3 and Figure 4. As

shown in Figure 3, in 2015, the first (most likely) spatial-temporal TB cluster was located in the Tanjung Karang Timur, Way Halim, Labuhan Ratu and Sukarame sub-districts, with a high and middle population density. In 2015, the secondary cluster was located in high population density areas: the Teluk Betung Selatan and Bumi Waras sub-districts. However, as seen in Figure 4, in 2016, the first (most likely) spatial-temporal TB cluster was located in the Kemiling sub-district, with a middle population density.

The overlay between the spatial-temporal TB cluster and the percentage of poverty is shown in Figure 5 and Figure 6. In Figure 5, the first (most likely) spatial-temporal TB cluster in 2015 was located in the Tanjung Karang Timur, Way Halim, Labuhan Ratu and Sukarame sub-districts; the percentage of poverty in those sub-districts was low and middle. In 2015, the secondary cluster 2 was located in the Teluk Betung Selatan and Bumi Waras sub-districts, with a middle percentage of poverty. In 2016, the most likely spatial- temporal TB cluster was located in Kemiling District, with a low percentage of poverty (Figure 6).

Discussion

The results demonstrate that the spatial-temporal dynamics in the TB clusters in 2015 and 2016 included the number of significant clusters, the number of TB cases in the clusters, the cluster locations and the cluster sizes. The dynamics of the significant number of TB clusters and the number of TB cases in the clusters was demonstrated by the differences in the number of TB clusters and the number of TB cases in the clusters for 2015 and 2016. In 2015, there were two significant clusters: one first (most likely) cluster and one secondary cluster 2. In 2016, there was only one cluster, the first (most likely) cluster. Moreover, in 2015, two significant clusters were residence to 278 of the 705 TB patients. In 2016, one significant TB cluster had 15 of 1,143 TB patients. Thus, the clusters in 2015 were residence to most of TB patients in that year. This result is in accordance with the findings reported in a research study conducted in China, which also showed that significant clusters tend to develop in areas with a high TB prevalence and notification rate.[20,21]

In the present study, significant clusters developed in the sub-districts with a high TB notification rate. In 2015, the first (most likely) cluster was found in the Labuhan Ratu, Kedaton, Way Halim and Sukarame sub-districts. The total notification rate in those sub-districts in 2015 was 143/100,000 people. In 2015, the secondary cluster 2

was found in the Teluk Betung Selatan and Bumi Waras sub-districts; in that year, the total notification rate in those sub-districts was 173/100,000 people. In 2016, although the cluster only consisted of a few TB patients, the cases were similar in terms of the time and location of the TB diagnosis. This finding is also supported by the large TB notification rate in the cluster area. In 2016, the notification rate in the Kemiling sub-district was 145/100,000 people. Moreover, in the present study, the notification rate in the cluster areas was higher than the notification rate in the non-TB clustered areas.

The results demonstrate that TB cluster dynamics also include shifting cluster locations. As previously mentioned, the locations of the TB clusters in 2015 included the Labuhan Ratu, Kedaton, Way Halim, Sukarame, Teluk Betung Selatan and Bumi Waras sub-districts. In 2016, the TB cluster location only included the Kemiling sub-district. Therefore, the locations of the TB clusters shifted between 2015 and 2016. This result is in line with the findings reported in studies conducted in Antananarivo, Madagascar and Linyi, China, which also found that the location of the TB clusters shifted. [9,22] However, the present study's results differ from the findings reported in a study conducted in Barcelona, Spain, which found that most of the space-time clusters were located in the same area. [23] The difference in these findings could be due to the fact that Spain has a low incidence of TB and only certain locations in that country had a high incidence of TB. [23] In contrast, Indonesia is a county with a high TB burden, and most areas have a high incidence of TB.

In the present study, although the location of the TB clusters shifted, the TB clusters in 2015 and 2016 had similar low social determinants. In 2015, the significant clusters were located in areas with a high population density; in 2016, the cluster was located in areas with a middle-high population density. A study conducted in Beijing also found that high population density was the major factor associated with the TB cluster in that city. [24] This result also indicates that TB in Bandar Lampung, Indonesia is distributed unequally based on high and middle population density. Previous research conducted in Bandar Lampung reported that most TB patients in that city live in overcrowded housing and overcrowded neighborhoods, which also increases the risk of TB being transmitted. [25]

Furthermore, in 2015 and 2016 the TB clusters were located in areas in which the percentage of poverty was either low or middle, not in areas with a high percentage of poverty. The cluster areas are located at the centre of Bandar Lampung or in

trading and industrial areas, which are more likely to have a clustered migrant population with a low socio-economic status. A study conducted in Hermosillo, Mexico reported that, due to demographics and urbanization, most of population was concentrated in the middle- and upper-class areas, which also have a middle and low percentage of poverty, respectively. Moreover, the residences with a low socio-economic status are clustered in certain sections of the studied areas. [11] A study conducted in China also showed that the migrant population contributed to a high TB prevalence and a significant number of TB clusters. [21]

In the present study, cluster dynamics included the size of the clusters. In 2015, the first (most likely) cluster radius was 4.40 km with 94 TB cases; the secondary cluster 2 radius was 2.21 km with 184TB cases. In 2016, the cluster radius was 1.98 km with 15 TB cases. The results show that, in 2015, the clusters covered a wider area and had more TB cases than the cluster in 2016. In 2015, for every one-kilometer radius there were approximately 84 TB patients. In 2016, for every one-kilometer radius, there were approximately eight TB patients.

Research conducted in the United States showed that the clusters with the highest TB incidence rate versus the expected incidence rate also had the highest number of matching isolates. A study conducted in Montreal, Canada also showed that areas with a high incidence of TB also had the same genotyping. The findings of both research studies imply that a cluster with a high number of TB patients tends to have local TB transmission. [26,27]

Based on the results presented above, the spatial-temporal dynamics in the TB clusters in 2015 and 2016, included the number of clusters, the number of TB cases in the cluster, the cluster location and the cluster size. Moreover, the TB clusters had similar social determinants: a middle-high population density and a low-middle percentage of poverty. The cluster with a TB incidence also implies the possibility of local transmission. The spatial-temporal dynamic information about TB clusters is very useful in supporting a TB control program, especially in high burden TB countries with a high population density and a high percentage of poverty.

Table 1. Spatial-Temporal Clusters of TB (2015) in Bandar Lampung

Cluster	n	Observed/ Expected	Expected	p value	Remarks
Most likely cluster	94	1,65	56,99	0,000021	Significant
Secondary cluster (2)	184	1,32	139,79	0,0021	Significant

Secondary cluster (3)	7	3,18	2,20	0,974	Not significant

Table 2. Spatial-Temporal Clusters of TB (2016) in Bandar Lampung

Cluster	n	Observed/ Expected	Expected	p value	Remarks
Most likely cluster	15	3,11	4,83	0,025	Significant
Secondary cluster (2)	13	2,84	4,57	0,286	Not significant
Secondary cluster (3)	166	1,27	131,16	0,450	Not significant

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PRIMARY SOURCES

1	Anantsuksomsri, Sutee, and Nij Tontisirin. "The Impacts of Mass Transit Improvements on Residential Land Development Values: Evidence from the Bangkok Metropolitan Region", Urban Policy and Research, 2015. Crossref	34 words —	1%
2	stacks.cdc.gov Internet	18 words —	1%
3	Lu, Wei, Cheng Chen, Yan Shao, Jinyan Shi, Chongqiao Zhong, Dandan Yang, Honghuan Song, Guoli Li, Xiaoyan Ding, Hong Peng, Linyang Zhu, Yang Zhou, and Limei Zhu. "Evaluation of Biochip System in Determining Isoniazid and Rifampicin Resistances of Mycobacterium Tuberculosis in Sputum Samples", PLoS ONE, 2012. Crossref	14 words —	1%
4	Bronner, Liza E, Laura J Podewils, Annatjie Peters, Pushpakanthi Somnath, Lorna Nshuti, Martie van der Walt, and Lerole Mametja. "Impact of community tracer teams on treatment outcomes among tuberculosis patients in South Africa", BMC Public Health, 2012. Crossref	12 words —	< 1%
5	"Motor control 1", Clinical Neurophysiology, 2000 Crossref	12 words —	< 1%
6	S. Naish. "Spatial and temporal clusters of Barmah Forest virus disease in Queensland, Australia : Clusters of Barmah Forest virus disease in Queensland", Tropical Medicine & International Health, 07/2011 Crossref	6 words —	< 1%

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