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Research Article

Spatial Analysis of Tuberculosis, Population and Housing Density in Yogyakarta

Muthia Ardiyanti [1,*], Sulistyawati [1], Yudha Puratmaja [2]

[1] Faculty of Public Health, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[2] Master of Public Health, Faculty of Public Health, Khon Kaen University, Khon Kaen, Thailand

*** Correspondence:** muthia1600029089@webmail.uad.ac.id. Phone: +6282328817403

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ABSTRACT

Background: Tuberculosis (TB) is an infectious disease that becomes a health problem globally, including in Indonesia. Yogyakarta City is a district that struggle with TB; from 2017-2018, there was an increase of TB case in this city. There was limited evidence concerning TB and its possible risk factors among TB case 2017-2018, mainly using GIS in Yogyakarta.

Method: This study used an ecological study design to determine the correlation between population and housing density with TB incidence in Yogyakarta City in 2017-2018. Secondary data was obtained from the Yogyakarta City Health Profile 2018-2019. Spearman rank correlation test and spatial analysis using Quantum GIS software were employed to analyse the data.

Results: There was a relationship between TB and population density variables (p-value = 0.034; R = -0.568) and housing density (p-value = 0.012; R = -0.625) in Yogyakarta, 2017-2018.

Conclusion: This study indicates that the density of housings and population affect the prevalence of Tuberculosis.

Keywords: Population density; Housing density; Spatial Analysis; Tuberculosis

INTRODUCTION

Tuberculosis (TB) is one of the top 10 infectious diseases - a significant health problem globally. Most TB bacteria attack the lungs but can also attack other organs. The transmission occurred through the air when a person with pulmonary TB coughs, sneezes, talks, or spits up. Most of the TB cases occurred in Southeast Asia (44%), Africa (24%), and the Western Pacific (18%). Globally, Indonesia is the third rank of TB case after India and China (1).

Yogyakarta Special Region (DIY) is one of the provinces that still have TB problems. In 2017, DIY reported the total number of TB cases as many as 2,785 cases and increased in 2018; there were 3,237 TB cases in 2018 (2). Yogyakarta City is part of the DIY province, which still struggles to combat TB. In 2017, the number of TB cases in Yogyakarta City was 551 cases,

of which 253 were confirmed as new cases (3). In 2018, the number of TB cases in Yogyakarta City had increased. According to the Yogyakarta City Health Profile in 2019, the highest number of TB cases was in the Umbulharjo I Health Center with 74 cases of all TB cases, while those confirmed with positive smear TB were 41 cases (4).

With an area of 32.50 km^2, the City of Yogyakarta's population density in 2018 was 12,703 people / km^2. The densest area is in the Gondomanan sub-district, 37,866 people / km^2, and the lowest population density is in the Kotagede sub-district with 6,038 people / km^2. The housing density in Yogyakarta City in 2018 was 3,113 units/km^2. The densest housing is in the Gedongtengen sub-district with 5,757 units/km^2, and the lowest housing density is in the Umbulharjo sub-district with 1,868 units / km^2 (4).

Population density affects TB incidence because it increases the possibility of contact with TB sufferers (5). Apart from population density, housing density can also affect the spread of TB disease because it is related to poor sanitation, slum places, lots of garbage if it not well maintained. Home is a place to grow and develop both physically, spiritually, and socially. The situation of the housing environment affects the health environment (6). According to Nafsi, who overviewed the spatial analysis of TB incidence based on housing density, all pulmonary TB cases were found in high housing density areas (7).

Every region has a different risk factor for TB disease. A spatial analysis approach is needed to help analyse risk factors, especially those related to geographic conditions, to develop the control measures (8). In the health sector, GIS can produce a spatial picture of health events, analyse the relationship between locations and the environment and disease incidence. Based on the existing environmental conditions, GIS can also stratify risk factors for disease (9). This research aimed to perform spatial analysis with the Geographic Information System (GIS) and risk factor analysis of population and housing density versus Tuberculosis (TB) in Yogyakarta City in 2017-2018.

METHOD

We used a quantitative study using an ecological study design with a Geographic Information System (GIS) approach. This research was conducted in Yogyakarta - July 2020 by including independent variables: population and housing density; the dependent variable is TB incidence. This study's population and the sample had an aggregate number of TB cases in Yogyakarta City in 2017-2018 per sub-district. Data were collected from Yogyakarta City Health Profile 2018-2019: TB cases, population density, housing density.

The analysis was performed in three steps: (1) univariate analysis, to determine the statistical distribution of each variable, including the independent variables (population density and housing density) and the dependent variable (TB incidence); (2) bivariate analysis, used to see the correlation of the independent variables (population density, housing density) with the dependent variable (TB incidence) by using an alternative test of Pearson's correlation, namely the Spearman rank test (3) spatial analysis using Quantum GIS to produce map depicting the spatial relationship of the independent variables (population density and housing density) with the dependent variable (TB incidence).

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RESULTS

There were 551 and 564 TB cases in Yogyakarta City during 2017 and 2018, respectively, that spread into 14 sub-districts. In 2017, the highest TB incidence was in the Umbulharjo sub-district with 89 cases and the lowest in Pakualaman sub-district with 4 cases. In 2018, the highest TB incidence occurred in the Umbulharjo sub-district with 110 cases and the lowest in Pakualaman sub-district with 11 cases (Table 1).

Table 1. Number of Tuberculosis Incidents in Yogyakarta City in 2017-2018

Sub-district	Number of Cases (Person)				Population Density (people / km2)				Housing Density (units / km²)			
	2017		2018		2017		2018		2017		2018	
	n	%	n	%	n	%	n	%	n	%	n	%
Danurejan	35	6	31	5	19255	9	33703	14	3661	8	3661	8
Gondokusuman	55	10	59	10	10598	5	6785	3	1917	4	1917	4
Gondomanan	22	4	30	5	13437	6	37866	16	2809	6	2811	6
Gedongtengen	32	6	34	6	21289	10	22340	9	5757	13	5757	13
Jetis	47	9	43	8	16068	8	11692	5	3270	8	3270	8
Kotagede	27	5	34	6	10978	5	6036	3	2364	5	2364	5
Kraton	34	6	40	7	15749	7	19940	8	2604	6	2604	6
Stimulating	41	7	38	7	13897	7	15284	6	2583	6	2583	6
Mantrijeron	45	8	31	5	13541	6	8408	4	3129	7	3129	7
Look	34	6	25	4	22704	11	18295	8	4173	10	4173	10
Nails	4	1	11	2	17121	8	17130	7	4806	11	4806	11
Tegalrejo	45	8	43	8	12709	6	11022	5	2155	5	2155	5
Umbulharjo	89	16	110	20	8542	4	8565	4	1868	4	1868	4
Wirobrajan	41	7	35	6	15861	7	19297	8	2489	6	2489	6

In 2017, the highest population density was in the Ngampilan sub-district with 22,704 people / km², and the lowest was in Umbulharjo sub-district with 8,542 people / km². In 2018, the highest population density was in the Gondomanan sub-district of 37,866 people / km², and the lowest was in the Kotagede sub-district of 6,036 people / km² (Table 1). Gedontengen sub-district was ranked as the highest housing density of 5,757 units / km², and the lowest was in the Gondokusuman sub-district of 1,917 units / km² (Table 1).

Bivariate analysis of population density and TB incidence in Yogyakarta City in 2017-2018, obtained r = - 0.568 and p-value = 0.034. There was a significant relationship between population density and TB with a p-value < 0.05. The statistical test showed that the relationship between population density and TB incidence has a strong relationship (r = 0.51-0.75) and has a negative direction where the lower the population density, the higher the TB incidence. There was a significant relationship between housing density and TB incidence in Yogyakarta City in 2017-2018 (p < 0.05) r = - 0.652. The statistical tests showed that the relationship between housing density and TB incidence had a strong relationship (r = 0.51-0.75) and had a negative pattern where the lower the housing density, the higher the TB incidence (Table 2).

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Table 2. Bivariate analysis between TB risk factors for TB incidence

Variable	R	*p-value*
Population density	- 0.568	0.034
Housing density	- 0.652	0.012

Figure 1 shows the distribution of TB incidence tends to the distribution of population density inversely. The high incidence of TB tends in areas with low to moderate population densities. Areas with low population density have a higher incidence of TB than regions with high population densities; for example, the Umbulharjo sub-district has a low population density but has a high TB incidence.

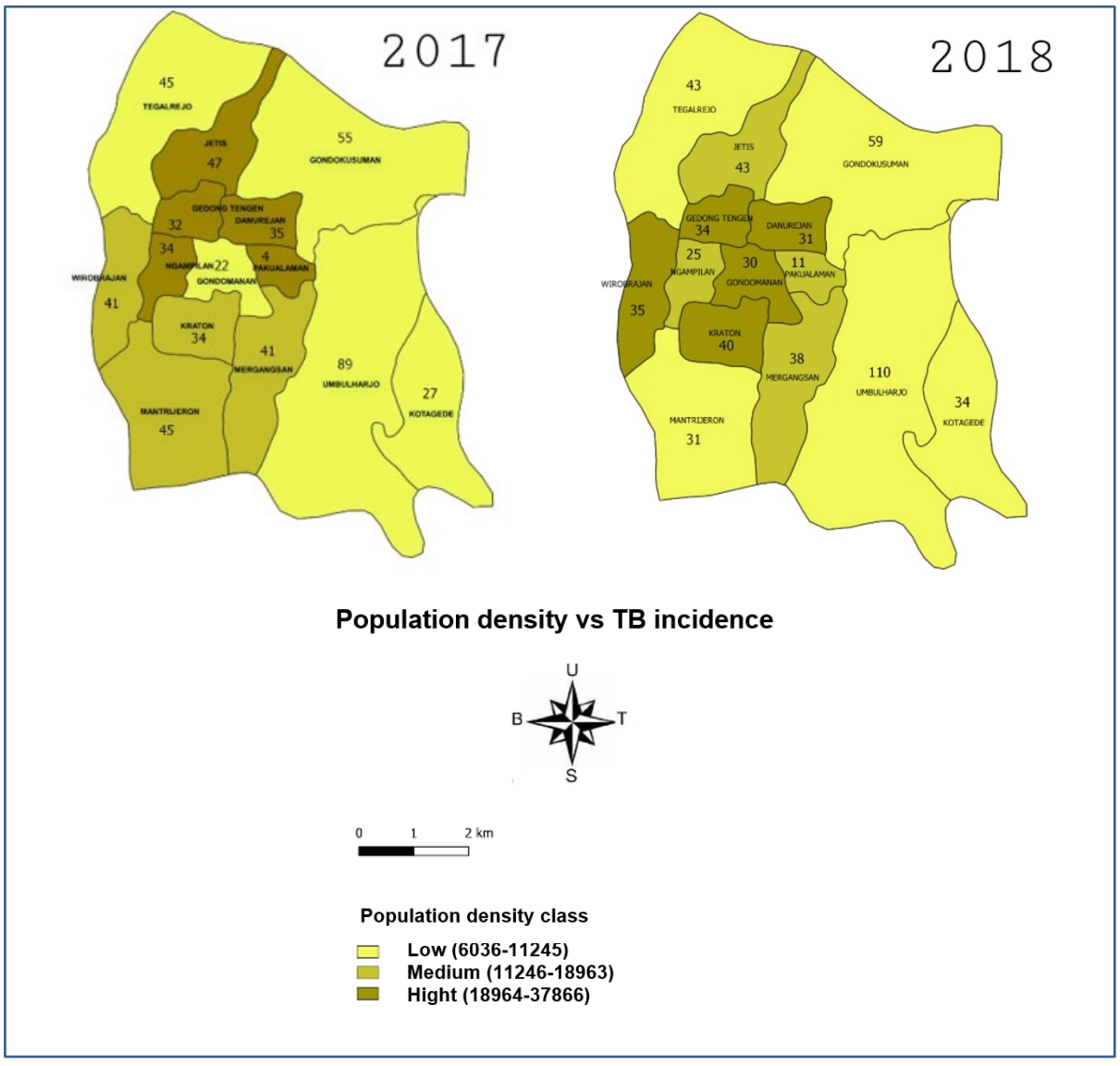

Figure 1. Map of Population Density vs the number of TB Incidence in Yogyakarta City 2017-2018 per sub-district

Based on Figure 2, the distribution of TB incidence tends not to follow housing density distribution. The high incidence of TB tends to be in areas with low to moderate housing

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densities. Areas with low housing densities have a higher incidence of TB than regions with high housing densities, such as Umbulharjo sub-district has a low housing density but has a high incidence of TB.

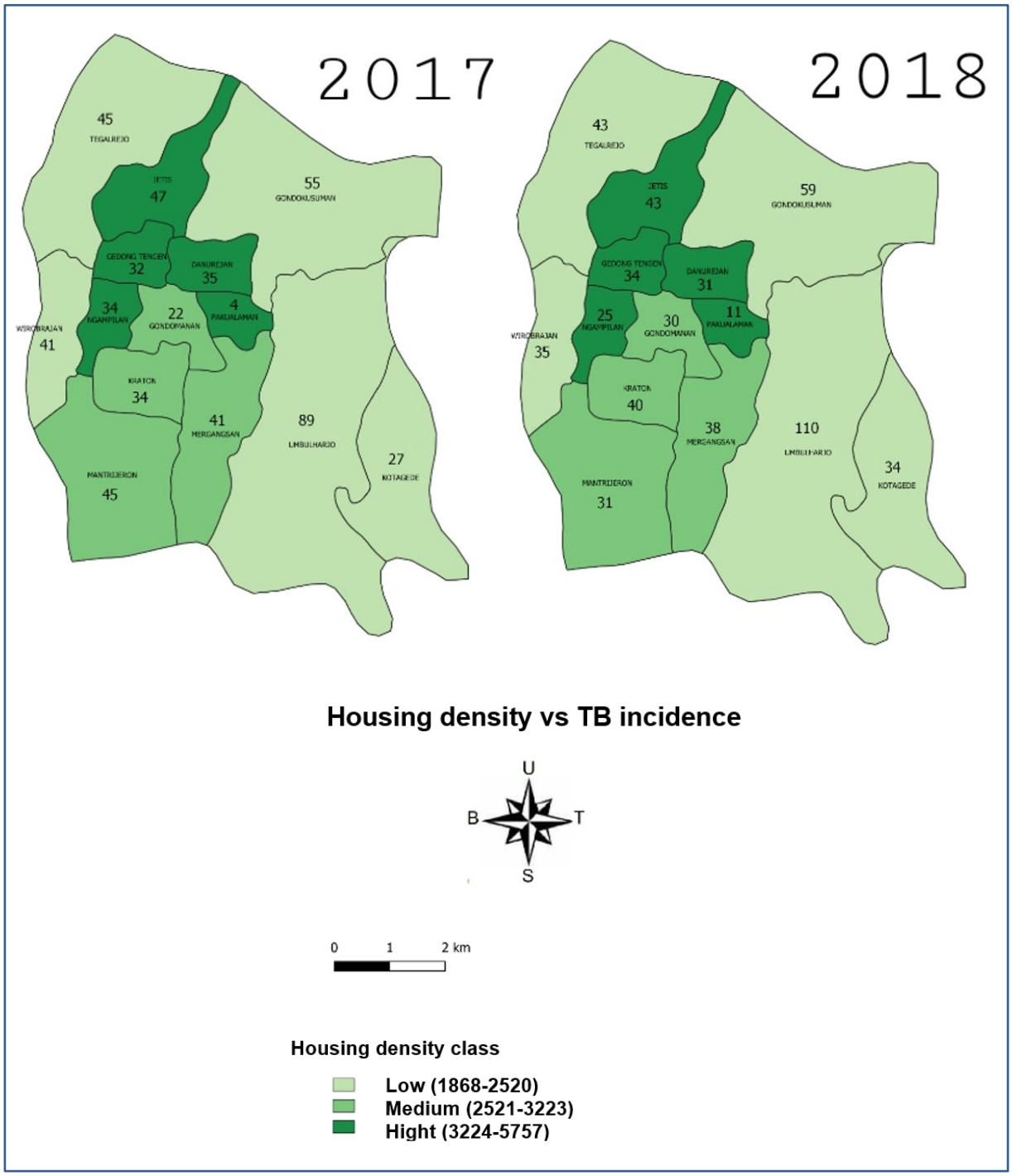

Figure 2. Housing Density Map vs the number of TB Incidence in Yogyakarta City 2017-2018 per sub-district

DISCUSSION

There was a statistically significant relationship between population density and TB incidence in Yogyakarta City in 2017-2018 (p-value < 0.05). The spatial analysis shows that the

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distribution of TB incidence in Yogyakarta City tends to distribute population density inversely. Wulandari, in her research, shows different results from this study - there is a significant relationship between population density and new cases of pulmonary TB AFB (+) in South Jakarta in 2006-2010 with p = 0.000, where an increase in population density is followed by the rise in TB cases (5). Our result is different from Achmad's research, which found no correlation between population density and the number of smear-positive pulmonary TB cases in South Jakarta in 2007-2009 with a p-value = 0.116 (10). The same finding found in other parts of Indonesia, which stated that there is no significant relationship between population density and the proportion of positive smear pulmonary TB in Kota Pariaman (p-value = 0.551), Bukittinggi (p-value = 0.140) and Dumai (p-value = 0.993) (11).

Some factors trigger a disease occurrence (12). Following the research conducted by Hastuti, Ahmad and Ibrahim in Kendari City, there was no significant difference between high population density and low population density and TB positive smear in Kendari City (13).

We found a relationship between population density and TB incidence, where the lower the population density, the higher the TB incidence. Spatially, the population density is not related to the TB incidence because the TB incidence does not follow the population density distribution. This finding can be seen in the Umbulharjo sub-district with the lowest population density among 14 sub-districts, namely 8,565 people / km², but has the highest TB incidents. Accordingly, the spatial pattern of population density does not affect the incidence of TB. Therefore, predicted other factors influence the increase in the number of TB cases in the Umbulharjo sub-district, such as nutritional status, socioeconomic conditions, housing's occupancy, the housing floor's condition, and ventilation, lighting, humidity, and altitude. According to Utami, ventilation is a risk factor for TB in the working area of the Umbulharjo I health centre; respondents who live in housing with poor ventilation are estimated to be 7.563 times more at risk of TB incidence compared to those who live in a large housing with proper ventilation (14).

Another thing that proves that population density is not the only risk factor contributing to TB incidence is that Gedongtengen and Danurejan sub-districts have relatively high population densities. Still, an increase does not follow this in the number of TB incidents. According to Dotulong, Sapulete and Kandou (15), age and sex are also risk factors for TB; a productive age and male are more susceptible to pulmonary TB. However, this study is not following the existing theory, where a densely populated area will undoubtedly cause disease transmission with a more complex chain of spread, especially in airborne diseases such as Tuberculosis.

Regarding the housing density, there is a statistically significant relationship between housing density and TB incidence in Yogyakarta City in 2017-2018 (p-value < 0.05). Spatial analysis shows that the distribution of TB incidence in Yogyakarta City tends the housing density distribution inversely. Umbulharjo sub-district has a low housing density but with high TB cases. The study results in Wonosobo, Central Java, showed the same results as this study: there was a significant relationship between housing density and TB incidence. Pratiwi, Pramono and Junaedi mentioned that someone who lives in an area with a high density of housings has 5 times higher risk of being exposed to TB than those who live in a low density (16). This shows that the density of housings affects TB incidence because dense environments may also have poor sanitation, slum areas, lots of garbage, and poorly maintained grounds, especially in developing countries (6).

We found that there was a statistically significant relationship between housing density and TB incidence but in a negative direction - the lower the housing density, the higher the TB incidence, and spatially the TB incidence did not follow the distribution of housing density - the lowest housing density had the highest number of cases. Umbulharjo sub-district has the lowest housing density (1,868 units / km²) but has a high TB incidence. This shows that the density of housings does not have a direct effect on the incidence of TB.

The needs for housing in the city of Yogyakarta is increasing in recent years. In Yogyakarta City, it was reported there were 3,304 housing is not habitable, unhealthy for habitation, spread unevenly in all sub-districts and villages. Housing not feasible for a living is considered slum areas caused by high-density settlements' environmental factors and the buildings' physical condition (17). The condition of the home environment has a close relationship with disease transmission, including TB. One of the housing conditions that can allow TB transmission is the density of occupancy. According to Utami, the housing density is a risk factor for TB incidence in the Umbulharjo Community Health Center's working area. Respondents who live in high occupancy homes that do not meet the as healthy housing are estimated to be 4.375 times more likely to be at risk of TB incidence than those who live in homes with low occupancy that meet healthy housing (14).

Thus, it is necessary to increase environmental-based TB control programs and healthy living behaviours. The role of sanitarians or environmental health workers is needed to prevent and eradicate TB disease by creating a healthy environment and healthy living habits, especially improvements in the sufferer and people living in areas with high housing densities and an increased number of TB cases. Increase education about healthy homes. Besides, TB control can be done by immunisation to boost immunity. Immunisation coverage is essential because it can prevent disease.

CONCLUSION

The spatial analysis results show no relationship between population density and housing density on the incidence of TB in Yogyakarta City in 2017-2018. In contrast, the statistical analysis results show a significant relationship between population density and housing density on the incidence of TB with $p < 0.05$ during 2017-2018 in Yogyakarta City.

Authors' contribution

MA was responsible for the design, data collection, analysis, and drafting of the manuscript. SS and YP were responsible for the design and analysis, and review of the manuscript.

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Conflict of interest

There is no conflict of interest in this research.

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