



Analysis of Healthy Housing and TB Prevalence in Yogyakarta City

Musfirah✉, Desi Nurfitra, Ahmad Faizal Rangkuti
Faculty of Public Health, Ahmad Dahlan University, Yogyakarta, Indonesia

Article Info

Article History:

Submitted January 2021
Accepted December 2021
Published January 2022

Keywords:

Physical Environment,
Urban; Healthy Housing, TB

DOI

<https://doi.org/10.15294/kemas.v17i3.28692>

Abstract

Environmental health is one of the determinants factors toward the public health status. Transmission of tuberculosis (TB) is influenced by environmental factors. Based on previous TB data in local study, it shows that urban areas (urban) have a high case rate. Therefore, this study aims to reveal the disparity of urban TB sufferers, especially in the city of Yogyakarta based on indicators of the physical environment of the house from the coverage of healthy households. The method of study used is quantitative descriptive analysis of secondary data. The data used were the physical environment of the house which is obtained from healthy housing data and TB prevalence data in Yogyakarta City. The secondary data spread over 18 Public Health Centers in Yogyakarta City. The data collected include healthy housing data and BTA (+) cases data in the study scope using total sampling technique. Based on the trend analysis, it was found that there was a significant trend in data. The higher percentage of non-healthy housing coverage was associated in line with the higher the TB prevalence rate. It can be concluded that the physical environment factor of the house as an indicator of a healthy housing is closely related to the incidence of TB in Yogyakarta City. Environmental quality studies need to be carried out for comprehensive TB disease control towards elimination (End TB 2030) which is in line with national programs and SDGs goals.

Introduction

Tuberculosis (TB) becomes world's communicable diseases (Álvaro-Meca et al., 2016). TB is a chronic infection which takes from weeks to months for manifestation of the disease by the *Mycobacterium tuberculosis* bacteria, whose spread is influenced by environmental factors through environmental air compartments (Muslimah & Dwi, 2019). This environmental-based disease still reaches high rates every year and important public health problem in Indonesia (Sugandi, et.al. 2018). The number of pulmonary TB patients in Indonesia was ranks fourth in the world after India, China, South Africa with a TB prevalence of 285 per 100,000 population or 302,861 cases in 2010 (WHO, 2010). According to the recapitulation of surveillance data from Provincial Health Office in Yogyakarta, in 2019 TB BTA (+) cases was still found in Yogyakarta City. The number of TB category BTA (+)

in Yogyakarta City has increased for three consecutive months, 32 cases in May, 37 cases in June, and 40 cases in July 2019.

TB cases related with environmental factors include physical environment (Schmidt, 2008). Environmental conditions, especially household conditions also have a role in the spread of pulmonary TB bacteria to healthy people (Taha et al., 2011). This study in line with Suharyo (2013) that the cleanliness of the households environment can also affect the spread of the virus, for example a house that is poor ceiling setting which can facilitate the spread of TB. The spread of pulmonary tuberculosis bacteria will attack healthy people more quickly if they are in a humid, less light and densely populated house (Handriyo & Wulan, 2017).

People exposed to a person with TB caused by household contacts (Singh et al., 2013). Household contacts become primarily

✉ Correspondence Address:
Faculty of Public Health, Ahmad Dahlan University, Yogyakarta, Indonesia.
Email: musfirah@ikm.uad.ac.id

risk factors for TB with high index cases, such as poverty, poor housing and environmental conditions (Sulis et al., 2014), health determinants, including HIV status, nutrition and access to healthcare (Loñnnroth et al., 2010). The previous study reported that prevalence of TB was found to be the highest among elderly people (0.9%), no education (0.4%) and people belonging to the poorest wealth quintile (0.53%) (Singh et al., 2018). In fact, there were multiple risk factors that are strongly associated with Tuberculosis such us smoking habit in house, cooking fuel type, floor, number of persons sleeping in a room (Narasimhan et. al., 2013) and individual characteristics such as age, sex, educational attainment, marital status, place of residence and wealth index (Singh et al., 2018; Shimeles et al., 2019).

The poor quality of physical environment in the house will be potential risk factors to the pulmonary TB diseases. It has attracted the attention of the author to further examine the perspective of the household environment quality as a determinant of TB incidence in urban areas and to formulate appropriate strategies for TB control. Therefore, this study aims to reveal the disparity of urban TB sufferers, especially in the city of Yogyakarta based on indicators of the physical environment of the house from the coverage of healthy households based on community data. Research is limited on this topic, so that environmental quality studies need to be carried out in a comprehensive TB disease control towards elimination of End TB 2030 program which is in line with national programs and SDGs goals.

Method

The method used in this study is quantitative descriptive analysis. The data used is the physical environment data of the house which is obtained from data on healthy houses in Yogyakarta City and TB prevalence data for Yogyakarta City in the period 2018-2020. The sample study comes from secondary data spread over 18 Public Health Centers in Yogyakarta City. The data collected include healthy houses data and BTA (+) cases data in the study scope. The sampling technique used the total sampling which the sample size similar as the population number, all secondary data sources from all health centers in Yogyakarta city. The data analysis used was descriptive analysis to describe the trend indicators for healthy households with TB incidence. Ethical approval for this study was approved in 2020 by the Ethics Committee of Ahmad Dahlan University No. : 012004016.

Result and Discussion

The tuberculosis prevalence rate describes the number of new TB patients and it is recorded per 100,000 population. The classifications of TB reported in the Yogyakarta City Health Office include bacteriological confirmed of pulmonary TB cases, clinically diagnosed pulmonary TB, and extra-pulmonary TB. There were four types of patients, including new patients, relapse patients, patients with a history of TB-treatment Apart From relapse, and patients with no previous history of TB-treatment. Here are graph of TB cases in Yogyakarta City in 2019 (Figure 1):

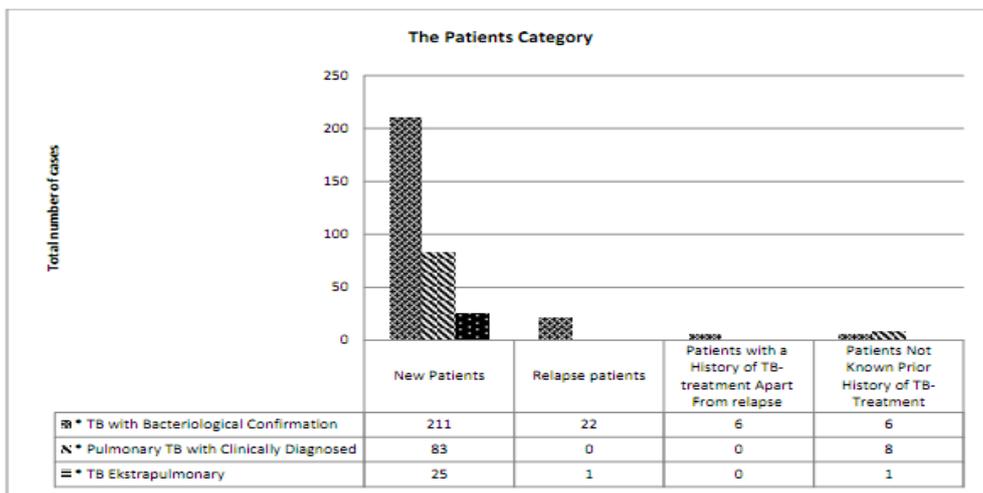


Figure 1. Graph of TB in Yogyakarta City in 2019

This study focuses on new bacteriologically confirmed pulmonary TB cases. The cases recorded at the Health Office of Yogyakarta City from the January-June Period (TW1-TW2) were 69 cases in 2020. Meanwhile, the Q3 data is still validation by the Yogyakarta City Health Office and Q4 2020 is still in the entry process at the respective public health center office. Based on 2020 data, there was a decrease in cases. Comparison of

bacteriological confirmed pulmonary TB cases in 2019 and 2020 can be seen in the following graph:

The jurisdiction area of the Health Office of Yogyakarta City has 18 public health centers unit. Each public health center carries out its TB surveillance function regularly. The following Figure 3 is a graph of new bacteriological confirmed pulmonary TB cases based on public health centers unit in 2019:

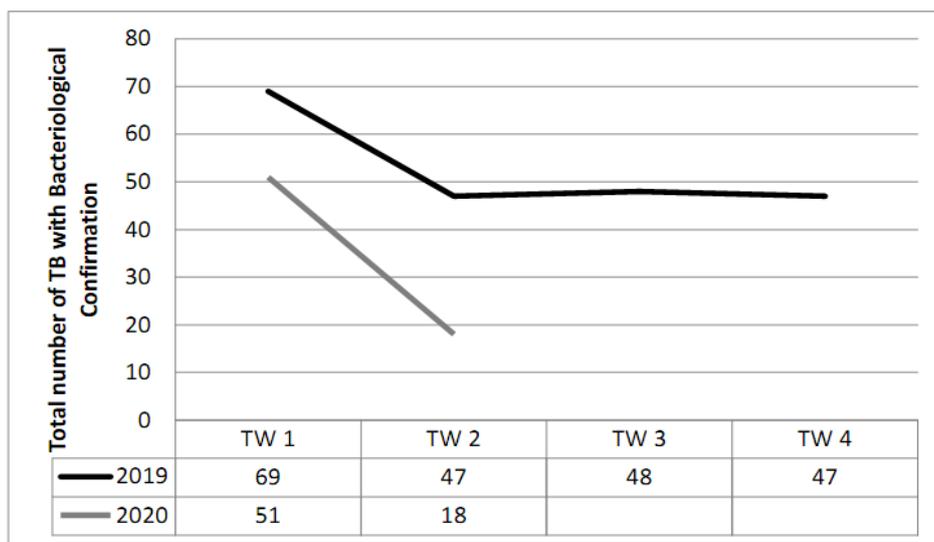


Figure 2. Comparison of Bacteriologically Confirmed Pulmonary TB Cases in 2019 and 2020

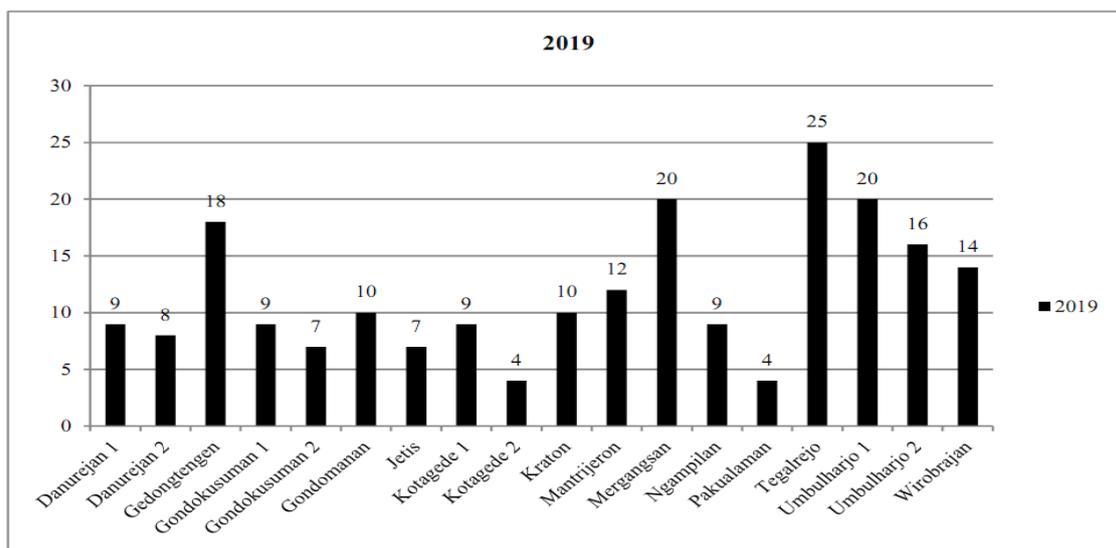


Figure 3. Graph of New Bacteriological Confirmed Pulmonary TB cases Based on Health Centers Unit in 2019

The TB case data in 2020 were showed in Figure 4 below which contains bacteriological confirmed data of New TB Patients, relapse

patients, patients with treatment history, and patients without treatment history.

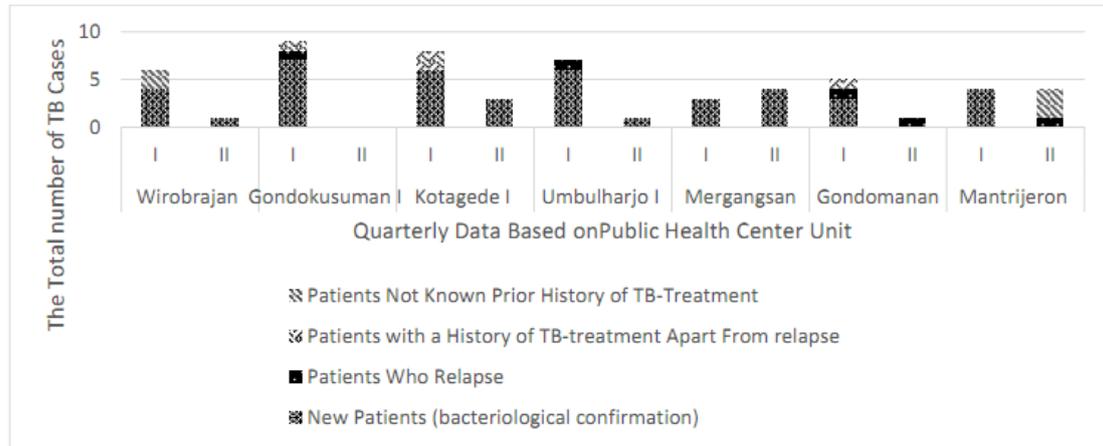


Figure 4. The Seven Highest TB Cases Data Based on Public Health Center for the Period January to June 2020

Based on the data Figure 4, the highest pulmonary TB cases were in the Kotagede I of Public health center and the lowest was found in the Gondomanan of public health center unit. The cumulative number of TB cases from the 7 (seven) health centers was 42 cases based on bacteriological confirmed data for TB patients. The fluctuation of data on bacteriologically confirmed New Pulmonary TB cases is very visible in the description of the quarterly data trend that has been presented both graphically and in table. During the pandemic, the trend of cases tends to decrease due to the lack of new visits and TB treatment. Even though during the Covid-19 pandemic, the continuity of Tuberculosis services must be pursued by ensuring services for TB patients and TB patients with resistance. Drugs or RO, both TB suspects and TB patients who are currently in the treatment stage should run without interruption and until they recover (Ministry of Health of the Republic of Indonesia, 2020).

Some of the challenges faced in the implementation of socialization and case finding screening activities during this online method pandemic, namely cadres are not too familiar with online mechanisms and prefer face-to-face activities with the community, constraints in operating social media and google forms, lack of community participation to fill in links online screening, limited pulse

quota, and limited care network. Regarding the referral and examination for tuberculosis, many of the people already have symptoms but refuse to go to the Public health center unit on the grounds that they feel healthy, enter the area with social distancing regulations, worry about contracting Covid-19 and personal safety when going to the Public health center unit, or restrictions from the examination over there (Ministry of Health of the Republic of Indonesia, 2020). TB patients must take action to be protected from COVID-19 and continue to treat TB as directed. Every TB patient will get a surgical mask that must be worn when the patient is in control of treatment and does highly important outside activities. TB patients are strongly advised to limit activities outside the households to avoid the possibility of being exposed to the SARS Cov-2 virus that causes COVID-19 (Pambudi, 2020). Identification of patients having a high risk becomes a reference in determining the choice of prevention, treatment and disease management strategy in formulating appropriate. The control method and efficient transmission approach should be taken to prevent disease transmission (Saifullah, et. al., 2021). COVID-19 has provided an opportunity to launching several form of adaptation TB care as a community approach, capacity building of human resources, and to combat the stigma that exists by multi-sectoral

approaches (Fatima, et. al., 2021).

Environment is one of the factors causing pulmonary TB incidence. The physical environment of the house is one of the environmental factors variables increases TB transmission. Based on Mahpudin's study, there was a relationship between the household environment and the incidence of TB. The healthy housing environment studied included room lighting, room ventilation, floor type, occupancy density, and household contact (Mahpudin & Mahkota, 2007). Based on data from the Yogyakarta City Health Office in 2018, the average coverage of healthy housing reached 96,29%. The healthy housing coverage according to public health centers data in Yogyakarta City in 2018 were listed in table 1.

The environmental factor also affects TB cases that covering the physical environment. Environmental conditions, especially healthy housing conditions also have a role in the spread of pulmonary TB bacteria to healthy people. The spread of pulmonary tuberculosis bacteria will attack healthy people more quickly if they are in a humid, less light and densely populated-house (Handriyo & Wulan,

2017). Environmental conditions playing a role in disease development were humidity and number of people living in the house. Housing densely populated and poor ventilation conditions increase the potential exposure to Mycobacterium tuberculosis (MTB) (Srivastava, et.al., 2015). Factors affecting the incidence of tuberculosis are related to the host and the environment. The study of tuberculosis can be started by identifying the number of family members per household, educational status, room area per person, history of contact with TB sufferers, availability and number of windows, location of kitchens in the house, and whether there are restrictions on contact with TB sufferers. People should build a house with a kitchen separate from the main living area, and add a ceiling and more than one window. In addition, smoking should be avoided indoors because this habit will contribute to the risk of TB transmission. Further research has also revealed that co-infection with human immunodeficiency viruses, worms, and malnutrition is important to control in TB prevention (Tesema et al., 2015)

Table 1. The Healthy Housing Coverages Data According to Public Health Centers in Yogyakarta City in 2018

Public health center	Total Households	A house that meets the requirements for a healthy housing	
		Total	%
Danurejan 1	1,571	1,521	96,82
Danurejan 2	2,456	2,165	88,15
Gondokusuman 1	5,353	5,344	99,83
Gondokusuman 2	2,297	2,242	97,61
Gondomanan	3,148	3,127	99,33
Gedongtengen	5,469	5,462	99,87
Jetis	5,559	4,931	88,70
Kotagede 1	3,809	3,788	99,45
Kotagede 2	3,447	2,867	83,17
Kraton	3,645	3,636	99,75
Mergangsan	5,967	5,960	99,88
Mantrijeron	8,167	7,731	94,66
Ngampilan	3,422	3,392	99,12
Pakualaman	3,028	3,027	99,97
Tegalrejo	6,271	5,860	93,45
Umbulharjo 1	10,652	10,616	99,96
Umbulharjo 2	4,516	4,514	99,96
Wirobrajan	4,381	3,891	88,82

The Trend Analysis of the Physical Environment For Healthy Households Indicators with TB Prevalence in the Yogyakarta City

Data on the healthy housing for the “non-healthy housing” category is obtained

from the difference between the 100% coverage of a healthy housing and the actual coverage of a healthy housing. If the “non-healthy housing” data is compared with the TB incidence (prevalence) data, the following graph will be showed (Figure 5):

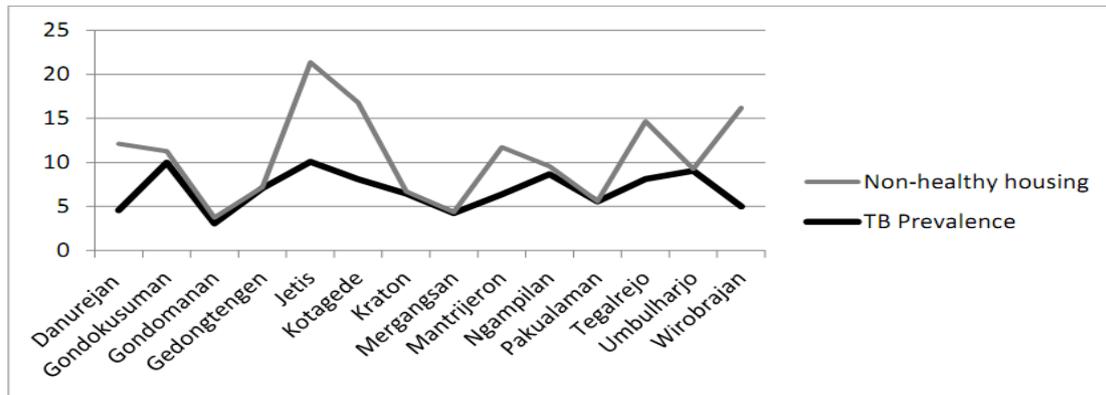


Figure 5. Graph of “Non-healthy Housing” and TB Prevalence-based Data Trends in Public Health Center in 2018

Based on the chart above, it can be seen that the trend of the data that the higher the number the house will not be healthy, because it will cause the higher the prevalence of their tuberculosis. This can be seen from the trend analysis in the chart above. When the number of unhealthy houses has decreased, the TB prevalence tends to fall and vice versa. This study examines the condition of the household environment with the incidence of TB in Yogyakarta City. The condition of the households environment is seen from secondary data on the number of non-healthy housing, where indicators of a healthy housing include building materials; components and house space arrangement; lighting; air quality; ventilation; infectious animals; water; available means of safe food storage; waste; and density of bed occupancy. Based on the results of the trend analysis, it was found that there was a possible relationship between non-healthy housing and the incidence of TB. The higher the number of non-healthy housing will impact to the higher the TB prevalence rate too. It can be seen from trend analysis chart carried out.

The results study were in line with other study which conducted by Sugandi et. al., (2018) that the healthy housing condition plays a role in the incidence of TB in Bandung as much as

73.75% of the population’s house condition in the good category. Each family who children exposed to TB cases actually caused by the lack of ventilation and lighting conditions in the house, besides that the inadequate house area is a trigger for the occurrence of TB cases in children. In addition to these factors, previous studies reported that there was a relationship between house occupancy density, ventilation, floor type, wall type, and household contact with a TB family with the incidence of pulmonary TB (Harfadhilah, et. al., 2013). Other studies contradict, only sunlight factor was associated with TB incidence. The factors of the presence of windows, windows opened every morning, room ventilation, lighting in the room, room humidity, and the presence of smokers in the house were not related to the incidence of TB (Musadad, 2006). Healthy housing and household phylogenic related to socio-demographic factors and the environment against the prevalence of pulmonary tuberculosis. It is expected that the Department of Health, community health centers and stakeholders can improve the prevention and control of pulmonary TB disease. A family-based approach is one of the right ways to reduce the risk of pulmonary tuberculosis so that it can increase the percentage of households with

healthy housing coverage and households with healthy behavior (Putri, et. al., 2019).

Healthy house indicators include building materials; components and house space arrangement; lighting; air quality; ventilation; infectious animals; water; available means of safe food storage; waste; and density of bed occupancy. The data obtained is the overall data, not the detailed data for each variable. Healthy household indicators that it can affect the incidence of TB include lighting, air quality, ventilation, and occupancy density; it can be a factor in the incidence of TB. There was a correlation between home environment factors and incidence of pulmonary TB transmission (Aditama, et. al., 2019). This study consistent with several previous studies, study on Muslim women which stated that temperature, humidity, and lighting were statistically proven to affect the incidence of TB, while ventilation, floors, walls, ceilings, and occupancy density were not statistically proven (Muslimah and Dwi, 2019). The associations between floor levels of residence and TB cases have been reported dependent on housing types because housing characteristics as main factor to explore an ecological study of the TB disease (Low et al., 2013). Another study stated that there was a significant relationship between occupancy density, humidity, ventilation area, and natural lighting with the incidence of pulmonary tuberculosis but there was no relationship between floor type and the incidence of pulmonary tuberculosis (Hamidah, et. al., 2015).

Direct natural lighting or sunlight can reduce the incidence of pulmonary tuberculosis transmission, because ultraviolet light from sunlight entering the house can kill TB germs. In other hand, housing environmental factors can increase the incidence of pulmonary TB include room ventilation, humidity, temperature, lighting, type of floor, and occupancy density (Duru et al., 2016). Then, relevant with other study that the risk of TB infection transmission was high in setting with increased number of person/room (OR=2,78), having tiny house (OR=4,25) poor ventilation system with less number of windows per room (OR=8,83) with p value of 0,0001. It was also reported that the risk of TB increased if the wall and floor of the

houses were built with mud/brick rather than cement (OR=2,50 and 1.89) with a significant p-value of 0.0001 (Khaliq, et. al., 2015).

Houses with less ventilation will affect the incidence of pulmonary tuberculosis. Household ventilation functions to remove polluted air (bacteria, CO₂) in the house and replace it with fresh and clean air or to circulate air where ultra violet light enters. In this study, ventilation was a risk factor associated with pulmonary tuberculosis. These results are consistent with previous study that there was a relationship between ventilation and the incidence of pulmonary tuberculosis. Residential density is one of the requirements for a healthy household according to the Ministry of Health of the Republic of Indonesia Number: 829 / Minister of Health / SK / VII / 1999. A household that has an occupancy density of > 9 m² meets the requirements for a healthy house. The density of occupancy is in one house, the greater the interaction that occurs between residents in the one house. The previous study only reported that people which living in crowded conditions were experience repeated and increase the TB infection for healthy people in the same house. Crowding was relationship both with risk of infection and risk of progression from infection to disease (Khan, 2016). The number of people per room was the only housing characteristic associated with progression to TB disease among infected participants, it caused by exposure to *M. tuberculosis* containing droplet particles during interactions in people's homes, it becomes making exchange rates within the range of values standard measured in air. The similar studies in New Zealand showed that TB incidence was associated with household crowding (Baker, et. al., 2008). The other study results were obtained from Low, et. al., (2013), reported that TB outcome could be characterized by dwelling characteristics such as housing type and height; they suggest that communities with poor household condition had a higher risk of TB. There were significant public health implications for Asian cities especially in high density urban living.

Environmental condition and host information related risk factors were very important to control the spread of infection

and disease (Khaliq, et. al., 2015). Household environmental conditions and indoor cleanliness are associated with the incidence of TB (Chen, et. al., 2021). Our study also shows credible results in the analysis of housing type by community. The actions needed to accelerate the reduction in the global burden of tuberculosis disease set for 2020, 2025, 2030 and 2035 consist of coverage in testing, case reporting, and overall access to health facilities, especially in developing countries, multi-sectoral efforts to reduce the prevalence of the major risks factor to disease infection and then increased investment in research and development (Floyd et al., 2018). The improvements in socio-environmental aspects are needed, but they must be combined with the improvement of education level (Cardoso, et. al., 2017). Thus, information regarding environmental and host risk factors is very important to control the spread of infection and disease (Khaliq, et. al., 2015).

Conclusion

The number of TB (BTA +) is increasing each year in terms of the distribution of data according to the focus of the study. The higher percentage of non-healthy housing coverage was associated in line with the higher the TB prevalence rate. It can be concluded that the physical environment factor of the house as an indicator of a healthy housing is closely related to the incidence of TB in Yogyakarta City. Environmental quality studies need to be carried out for comprehensive TB disease control towards elimination (End TB 2030) which is in line with national programs and SDGs goals.

Acknowledgment

The research was funded by the Basic Research Grant of the Ahmad Dahlan University Institute for Research and Community Service (LPPM) With Contract No. PD-164 / SP3 / LPPM-UAD / 2020. The authors would like to thank to Yogyakarta City Health Office for their support. Appreciations were also granted for all secondary data collectors and team member of this study.

References

- Aditama, W., Sitepu, F.Y., & Saputra, R., 2019. Relationship between Physical Condition of House Environment and the Incidence of Pulmonary Tuberculosis, Aceh, Indonesia. *Int J Sci Healthc Res*, 4(1), pp. 227-231.
- Álvaro-Meca, A., Díaz, A., de-Miguel, D.J., Resino, R., & Resino, S., 2016. Environmental Factors Related to Pulmonary Tuberculosis in HIV-Infected Patients in the Combined Antiretroviral Therapy (cART) Era. *PLoS One*, 11(11).
- Baker, M., Das, D., Venugopal, K., & Howden-Chapman, P., 2008. Tuberculosis Associated with Household Crowding in a Developed Country. *J Epidemiol Community Health*, 62(8), pp. 715-21.
- Cardoso, B.A., Fonseca, F.D.O., Moraes-Neto, A.H.A.D., Martins, A.C.G.S., Oliveira, N.V.D.S., Lima, L.N.G.C., Dias, G.A.D.S., & Saad, M.H.F., 2017. Environmental Aspects Related to Tuberculosis and Intestinal Parasites in a Low-income Community of the Brazilian Amazon. *Revista do Instituto de Medicina Tropical de São Paulo*, 59.
- Chen, Y., Peng, W.H., Lai, S.F., Luo, F., Luo, D., & Wang, B.G., 2021. Association of Gene Polymorphisms and Environmental Factors in Tuberculosis Patients and Their Household Contacts. *Transactions of The Royal Society of Tropical Medicine and Hygiene*, 115(1), pp.20-29.
- Provincial Health Office in Yogyakarta Special Region., 2019. *Discovery of TB Cases in DIY for the Period of July 17, 2019*. Yogyakarta.
- Duru, C.B., Iwu, A.C., Uwakwe, K.A., Diwe, K.C., & Merenu, I.A., Pulmonary Tuberculosis Preventive Practices and Its Determinants among Residents in Communities in Orlu, Imo State, Nigeria. *Int. J. Sci. Healthc. Res.*, 1, pp.57-69.
- Fatima, R., Akhtar, N., Yaqoob, A., Harries, A.D., & Khan, M.S., 2021. Building Better Tuberculosis Control Systems In A Post-COVID World: Learning From Pakistan During The COVID-19 Pandemic. *International Journal of Infectious Diseases*, 2021.
- Floyd, K., Glaziou, P., Zumla, A., & Raviglione, M., 2018. The Global Tuberculosis Epidemic and Progress in Care, Prevention, and Research: An Overview in Year 3 of the End TB era. *Lancet Respir Med.*, 6(4), pp.299-314.

- Hamidah., Kanda, G.D., & Posangi, J., 2015. Relationship between the Quality of the Physical Environment of the House and the Incidence of Pulmonary Tuberculosis in the Working Area of the Siko Nursing Health Center, North Ternate District, Ternate City, North Maluku Province. *J e-Biomedics*, 3(3).
- Handriyo, R.G., & Dyah-Wulan, S.R.W., 2017. Social Determinants as Risk Factors for Pulmonary Tuberculosis Incidence at the Public Health Center of Panjang. *J Major*, 7(1), pp.1-5.
- Harfadhilah, D., Noor, N.N., & Sunarka, I.N., 2013. Analysis of Environmental Risk Factors for the Incidence of Pulmonary Tuberculosis. *Medula*, 1(1), pp.7-13.
- Khaliq, A., Khan, I.H., Akhtar, M.W., & Chaudhry, M.N., 2015. Environmental Risk Factors and Social Determinants of Pulmonary Tuberculosis in Pakistan. *Epidemiology (sunnyvale)*, 5, pp.201.
- Khan, F.A., Fox, G.J., Lee, R.S., Riva, M., Benedetti, A., Proulx, J.F., Jung, S., Hornby, K., Behr, M.A., & Menzies, D., 2016. Housing and Tuberculosis in an Inuit Village in Northern Quebec: A Case-control Study. *CMAJ Open*, 4(3), pp.E496-E506.
- Lawn, S.D., & Zumla, A.I., 2011. Tuberculosis. *Lancet*, 378, pp.57-72.
- Lo'nnoth, K., Castro, K.G., Chakaya, J.M., Chauhan, L.S., Floyd, K., Glaziou, P., & Raviglione, M.C., 2010. Tuberculosis Control and Elimination 2010-50: Cure, Care, and Social Development. *Lancet*, 375, pp.1814-1829.
- Low, C.T., Lai, P.C., Tse, W.S., Tsui, C.K., Lee, H., & Hui, P.K., 2013. Exploring Tuberculosis by Types of Housing Development. *Soc Sci Med.*, 87, pp.77-83.
- Mahpudin, A.H., & Mahkota, R., 2007. Home Physical Environmental Factors, Biological Responses and Incidence of Pulmonary Tuberculosis in Indonesia. *Kesmas Natl Public Heal J.*, 1(4), pp.14.
- Ministry of Health Republic of Indonesia., 1999. *KEPMENKES No 829/Menkes/SK/VII/1999 tentang Persyaratan Kesehatan Pemukiman*. Jakarta.
- Ministry of Health Republic of Indonesia., 2020. Indonesia Commitment to Eliminate TB by 2030 Supported by the Highest-level Government. *Tuberculosis Elimination Bulletin*, 1.
- Musadad. A., 2006. Relationship between Environmental Factors and Households Contact with Pulmonary Tuberculosis. *Health Ecol.*, 5(3), pp.486-96.
- Muslimah, L., & Dwi, D., 2019. Physical Environmental Factors and Its Association with the Existence of Mycobacterium Tuberculosis: A Study in The Working Region of Perak Timur-Public Health Center. *J Environmental Health*, 11(1), pp.26.
- Narasimhan, P., Wood, J., MacIntyre, C.R., & Mathai, D., 2013. Risk Factors for Tuberculosis. *Pulm Med.*, 2013, pp.1-11.
- Pambudi, I., 2020. TB Service Protocol During the Covid Pandemic. Dit. P2PML, Ditjen P2P, *Ministry of Health Republic of Indonesia*.
- Putri, A.S.E., Tari-Amanda, R., & Ilham, R., 2019. Mapping of Tuberculosis (TB) Prevalence in Padang City. *Indian Journal of Public Health Research & Development*, 10(3).
- Saifullah, A., Mallhi, T.H., Khan, Y.H., Iqbal, M.S., Alotaibi, N.H., Alzarea, A.I., & Rasheed, M., 2021. Evaluation of Risk Factors Associated with the Development of MDR- and XDR-TB in a Tertiary Care Hospital: A Retrospective Cohort Study. *PeerJ.*, 9, pp.:e10826.
- Schmidt, C.W., 2008. Linking TB and the Environment: An Overlooked Mitigation Strategy. *Environmental Health Perspectives*, 116(11), pp.A478-A485.
- Shimeles, E., Enguselassie, F., Aseffa, A., Tilahun, M., Mekonen, A., Wondimagegn, G., & Hailu, T., 2019. Risk Factors for Tuberculosis: A Case-control Study in Addis Ababa, Ethiopia. *PLoS ONE*, 14(4), pp.1-19.
- Singh, J., Sankar, M.M., Kumar, S., Gopinath, K., Singh, N., Mani, K., et al., 2013. Incidence and Prevalence of Tuberculosis Among Household Contacts of Pulmonary Tuberculosis Patients in a Peri-urban Population of South Delhi, India. *PLoS One*, 8(7), pp.1-11.
- Singh, S.K., Kashyap, G.C., & Puri, P., 2018. Potential Effect of Household Environment on Prevalence of Tuberculosis in India: Evidence from the Recent Round of A Cross-sectional Survey. *BMC Pulmonary Medicine*, 18(1), pp.1-10.
- Srivastava, K., Kant, S., & Verma, A., 2015. Role of Environmental Factors in Transmission of Tuberculosis. *Dynamics of Human Health*, 2(4).
- Sugandi, Y.S., Soemarwoto, R., & Mardotillah, M., 2018. Healthy Home Social Movement and BCG Immunization as a Step to Reduce the Incidence of Tuberculosis (TB) in Children. *Humanika*, 25(1), pp.38-50.
- Suharyo., 2013. Determination of Tuberculosis Disease in Rural Areas. *KEMAS: Journal of Public Health*, 9(1), pp.85-91.

- Sulis, G., Roggi, A., Matteelli, A., & Raviglione, M.C., 2014. Tuberculosis: Epidemiology and Control. *Mediterranean Journal of Hematology and Infectious Diseases*, 6(1).
- Taha, M., Deribew, A., Tessema, F., Assegid, S., & Duchateau, L., 2011. Risk Factors of Active Tuberculosis in People Living with HIV/AIDS in Southwest Ethiopia. *Ethiop J Health Sci.*, 21, pp.131–139.
- Tesema, C., Tadesse, T., Gebrehiwot, M., Tsegaw, A., & Weldegebreal, F., 2015. Environmental and Host-related Determinants of Tuberculosis in Metema District, North-west Ethiopia. *Drug, Healthcare and Patient Safety*, 7, pp.87.
- WHO., 2010. *Global Tuberculosis Control 2010*. WHO Press. Geneva: World Health Organization.