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# The role of socioeconomic and environmental factors on the number of tuberculosis cases in Indonesia

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**Abstract:** The threat of TB continues to occur in the world. In 2018, 10 million people suffered from TB, and 1.5 million people die from this infectious disease. Referring to target 3 of Sustainable Development Goals (SDGs) goals 03 regarding good health and well-being, by 2030, end the epidemic of AIDS, TB, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases. Based on data from the WHO, Indonesia ranks 3rd for TB cases globally. The estimated population suffering from TB is 845,000 cases; only 68 percent of cases were found and treated in 2018. The high number of TB cases in Indonesia could threaten the golden generation's opportunity in the next 2025 demographic bonus, where the number of productive age population is higher than the population non-productive age. This study found that population factors such as population, population density, and the number of poor people had a positive and significant effect on TB cases. In contrast, the GRDP per capita, the number of health workers, and literacy rates negatively affected the TB cases.Furthermore,environmental factors from the availability of proper sanitation and toilet facilities show a negative but insignificant effect on TB cases.

**Keywords:** health, population, poverty, socioeconomic, tuberculosis

**JEL Classification:** H51, I15, I18, I32, P25, Q01

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## 1. INTRODUCTION

Health has a vital role in the economic development of a nation. That way, advanced economic development will never be achieved if an infectious disease prevalence occurs in a community or nation. The better the social security program, health service facilities, and health resources owned, the better it will be in handling health when an outbreak occurs that affects the community in the community or nation. One of the epidemics that are still of concern to the world is tuberculosis (TB). Until now, no country has been free from TB. The World Health Organization (2019) reports that as many as 1.5 million people died from TB in 2018 (including 251,000 people with HIV). In the world, TB is one of the top 10 causes of death or the leading cause of an infectious agent (above the case of HIV/AIDS). A total of 38 countries with a high burden of TB have accounted for 87% of new TB cases. Eight countries contribute two-thirds of total global TB cases, namely India, with the highest percentage, followed by China, Indonesia, Philippines, Pakistan, Nigeria, Bangladesh, and South Africa.

In Indonesia, TB is an epidemic that causes morbidity and mortality and the high health costs that must be paid. As Kompas (2020) reported, in 1971, around 60 million people, or half of Indonesia's Population, contracted the TB germ (Kompas, 2020). Data and Health Profile Information 2018 show

that the number of TB cases of all types (male + female) was 511,873 cases. The highest cases were in West Java, with 99,398 cases, Central Java with 67,063 cases, and East Java with 56,445 cases. The poor health condition of people affected by TB harms the economy in the region and Indonesia. The high number of TB cases in Indonesia is caused by the dominant predisposition factors, including socioeconomic conditions, knowledge, and education level that people have on health. Also, health facilities and infrastructure influence the maximization of the treatment process for residents suffering from TB.

Building health infrastructures, such as hospitals, health centers, doctors, and nurses, is vital to treat TB. For this reason, the efficiency of reform in the health sector and the Sustainable Development Goals (SDGs) accompanied by a detailed analysis of each component of the reform must be carried out (Boyacioğlu, 2012). In the provisions of the Law on Health (Law No. 36/2009), the allocation of spending in the health sector must be fulfilled. The article states that the budget allocation for health expenditures is at least 5% of the State Budget (APBN) excluding salaries, and for local governments, both levels I and II, the budget allocation for health is at least 10% of the Local Government Budget (APBD) excluding salaries. The purpose of this article is to achieve a health status that continues to improve. Speybroeck et al. (2006) stated that the higher the ratio of health workers in a region or country, the higher the health care for people in that region or region. In 2018, the workforce and provinces' recapitulation of health resources in Indonesia was 1,182,808 health workers. However, there is still a maldistribution of doctors and nurses in several provinces in Indonesia, such as the Bangka Belitung Islands, Jakarta,Yogyakarta, and West Papua. It can affect the increasing cases of TB in Indonesia.

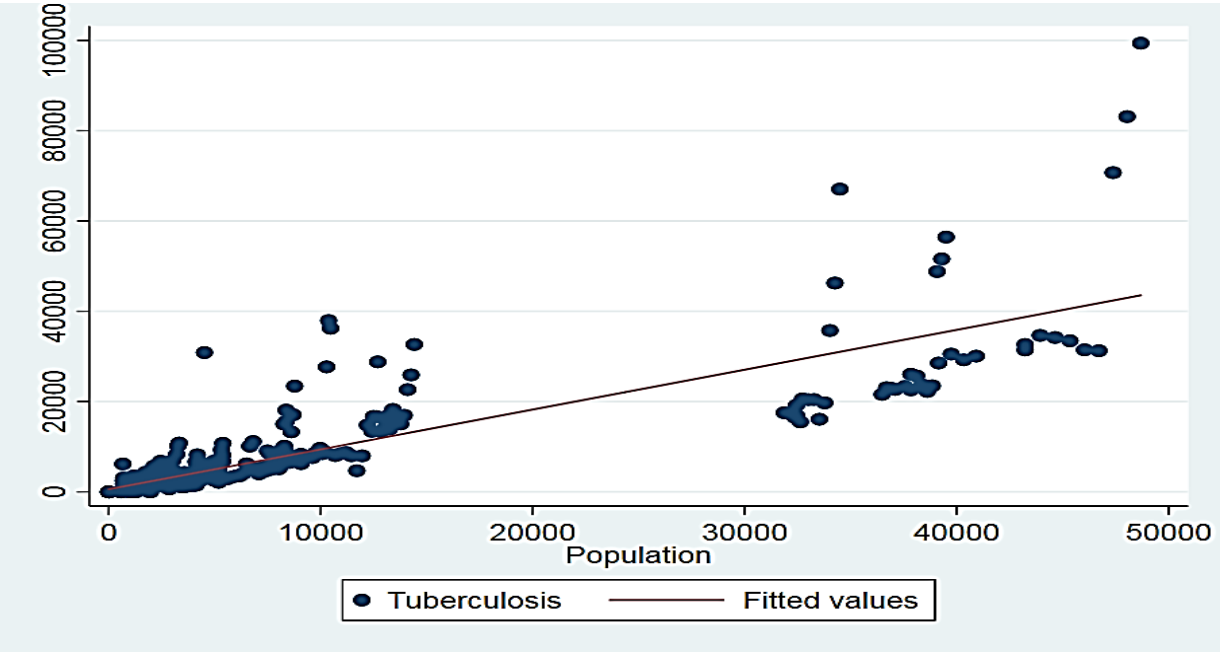


**Figure 1.**The Number of Tuberculosis Cases and Population in Indonesia, 2005-2018
**Source:** Central Bureau of Statistics, Ministry of Health, Author's Calculation

TB is an ancient disease that has been affecting humans for more than 4000 years (Zaman, 2010); the threat is re-emerging to the lives and health of people around the world(Gandy & Zumla, 2002; Santic & Galic, 2013). In Indonesia, TB is one of the disease outbreaks that focus on the national strategic agenda. Several groups of people who are considered vulnerable to contracting TB germs are children, the elderly, people with HIV/AIDS, people with diabetes mellitus, poor and vulnerable people, people

living in densely populated areas, and people living with TB sufferers. With Indonesia's high population, there is a tendency to increase the number of TB cases in Indonesia (See Figure 1.) Provinces that have a high population have a high number of TB cases. West Java, East Java, Central Java, Jakarta, and North Sumatra are provinces that have a high number of TB cases. Apart from having a high population, the five provinces have a high population density. Public health conditions correlate with demographic conditions. The higher the trend of population growth and population density, the worse the public health condition will be if there are many outbreaks such as TB, which is transmitted rapidly through droplets.

The rapid development of the Indonesian economy has resulted in significant population mobility in various provinces. Figure 1 indicates that a province with a large number of migrants is a population that is susceptible to contracting diseases such as TB. In populated areas strengthening TB monitoring systems and approaches through intervention will be critical factors in controlling the number of TB cases. TB cases spreadabout medical and socioeconomic factors such as high urbanization, poverty, population density, poor sanitation, and housing. The fast and slow spread of TB germs can occur due to the population's density and population distribution in residential areas with poor air ventilation and lighting quality. Contributed to the spread of TB to other family members who live together in the house, because of the TB germs will survive for 1-2 hours to several days depending on the condition of the house with the presence or absence of air ventilation, windows for the entry of sunlight, humidity, room temperature and the density of the house's occupancy.

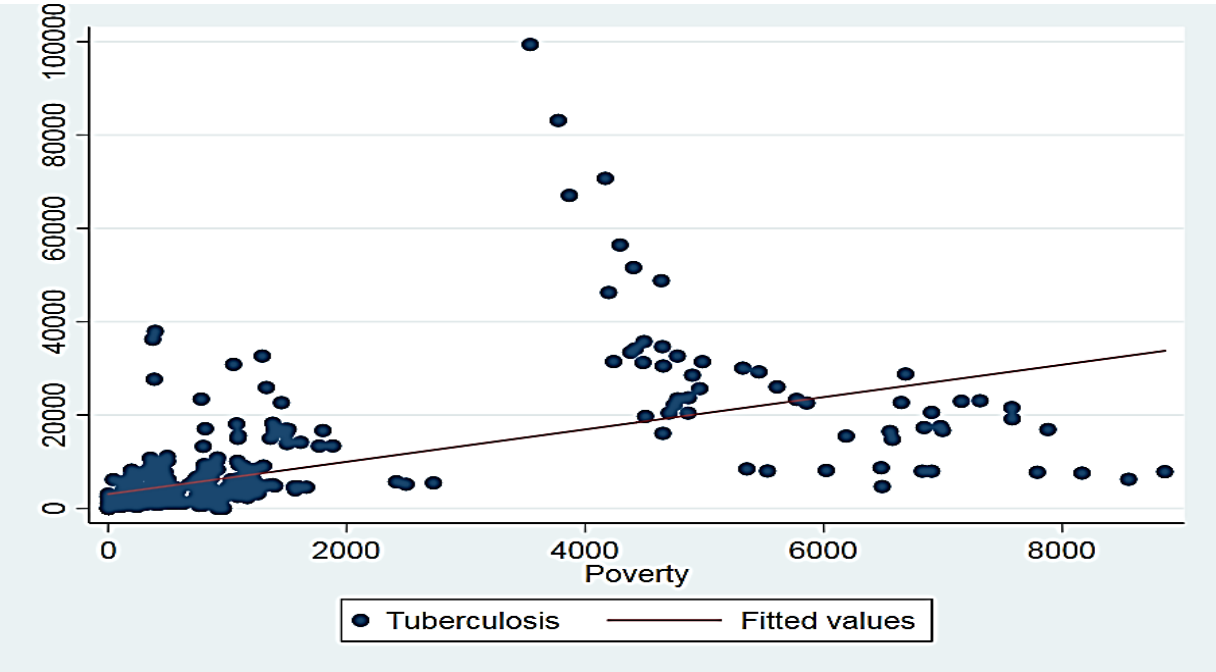


**Figure 2.**The Number of Tuberculosis Cases and Poor of People in Indonesia, 2005-2018
**Source:** Central Bureau of Statistics, Ministry of Health,Author's Calculation

Poverty is closely related to TB(Marais et al., 2009); this can increase the risk of Mycobacterium TB infection and active disease but limits the chances of diagnosis (Wong et al., 2013). Provinces with a high number of poor people tend to have a high number of TB cases (See Figure 2). The indication from Figure 2. is that poverty has facilitated the transmission of the Mycobacterium TB germ, primarily through its effect on the living conditions of households that have a house with a large number of family members. The quality of the hospitality environment with low air ventilation quality, inadequate water

availability, sanitation and hygiene (WASH), prolonged delay in diagnosis due to lack of access to health facilities, malnutrition, or being infected with HIV/AIDS are also the causes of rapid transmission of TB. Figure 2 shows a correlation between the number of poor people and the high number of TB cases in Indonesia. In 2018, some provinces had a high number of poor people but had a lower number of TB cases, and some provinces have a low number of poor people but have a high number of TB, namely West Java with a poor people of 3,539 million and 99,398 thousand TB cases, Central Java 3,967 million and 67,063 thousand TB cases, and East Java 4,292 million and 56,455 TB cases.

This phenomenon can illustrate that TB cases' rate is about the economy—Caminero (2008) states a negative relationship between TB cases and a country's income per capita. If the community's income per capita is high, the purchasing power job opportunities will improve so that the need for nutrition, education, and health will increase the community's standard and quality of life and reduce poverty. Another economic factor is that if TB control efforts are not increased, it will cost the global economy $1 trillion and kill 28 million people between 2005 and 2030(Global TB Caucus, 2017). This estimate is based on a "business as usual" scenario, in which progress from various fields continues to date. The report also noted that during 2000-2015, infectious diseases such as TB cost the economy $ 616 billion in countries on the African continent, and in Southeast Asia, this loss cost 1% of GDP. Many experts projected a country like India to lose $252.7 billion and Lesotho and Mozambique to face a loss of 3% of GDP. Experts estimate that the cost of losses will reach $ 984 billion, nearly half of which will go to countries on the African continent (Burki, 2018).

The environment has a vital role in the health status of society, followed by lifestyle. Environmental health is a condition for the realization of an optimum health standard. The scope of environmental health includes proper housing, disposal of feces, availability of proper drinking water and clean water, disposal of garbage and waste, and availability of proper sanitation(Kustanto, 2020b). A healthy environment with proper sanitation and toilet facilities affects the surrounding community's health, including reducing the transmission rate and the number of TB cases (Mariana et al., 2020). The availability of good essential services such as sanitation and ownership of toilets itself will impact public health. However, currently, having access to proper water, sanitation, and hygiene (WASH) is a national health problem. In 2017, theWorld Health Organization (2017)reported Progress on Drinking Water, Sanitation, and Hygiene 2017, noted that Indonesia was in third place with poor access to sanitation. India and second place occupy the first rank by China. In another report from theUnited Nations Children's Fund (UNICEF) Indonesia, nearly 25 million Indonesians do not have access to ownership of their toilets and septic tanks. The habit of defecating in the same toilet as other users with TB can spread to other toilet users. These environmental factors can trigger the spread of TB.

TB can be seen as a public health problem and a population and environment problem in which the community lives. This study will examine the role of socioeconomic and environmental factors in the number of TB cases. In developing countries, TB cases may be higher in some areas with a high population and population density, a high number of poor people and slum neighborhoods, including in urban areas, and many TB case; this indicates that no population is immune and isolated from the risk of contracting TB.

## 2. LITERATURE REVIEW

According to the World Health Organization (2019), TB is an infectious disease that is the leading cause of lung health and is one of the ten leading causes of death worldwide from a single infectious agent (above HIV/AIDS cases). The bacteria Mycobacterium tuberculosis causes TB, spread when a person with TB expels bacteria into the air,such as coughing. There are several species of Mycobacterium, including Mycobacterium tuberculosis, Mycobacterium Africanum, Mycobacterium Bovis, Mycobacterium Leprae. Also known as acid-resistant bacteriapositive. The Mycobacterium group of bacteria other than Mycobacterium tuberculosis, which can cause disorders of the respiratory tract,

is known as Mycobacterium Other Than Tuberculosis (MOTT) diagnosis treatment of TB. The main symptom of pulmonary TB patients is a cough with phlegm for two weeks or more. Additional symptoms can follow coughing; namely, phlegm mixed with blood, coughing up blood, shortness of breath, weakness, appetite and weight loss, malaise, night sweats without physical activity, chills for more than one month (Ministry of Health, 2018). Socioeconomic interventions to strengthen TB control by directly improving TB care and prevention services. This strategy uses the Directly Observed Treatment Short Course (DOTS), which is direct supervision in the short term with the obligation for TB program managers to focus their attention on finding sufferers by examining microscopes (Rocha et al., 2011). This strategy is an effort to reduce the morbidity and mortality rates of TB. DOTS is also one of the most significant public health financing interventions implemented in various countries (Hargreaves et al., 2011).

The community's socioeconomic status can affect all stages of the pathogenesis of TB (Duarte et al., 2018). Economic growth and poverty reduction will be essential elements in reducing TB cases (Lönnroth et al., 2010). Therefore, in order for economic growth to contribute effectively in controlling TB cases, it is necessary to have the right combination of health and public policies. This would prove that apart from medical care, there is increasing evidence of the role of socioeconomic factors in TB's health and epidemiology.

The World Bank in Poverty and Shared Prosperity 2018 reports that around 10.76 percent or 767 million of the world's population are in the extreme poverty line with an expenditure of $1.90 per day to meet their daily needs. It implies that TB is closely related to poverty. TB transmission can increase in poor and vulnerable groups of people due to unfavorable socioeconomic conditions. Bhunu et al. (2012) stated that the poor and vulnerable are more likely to contract TB than the rich. This difference in socioeconomic conditions has occurred in India as evidenced by a study (Oxlade & Murray, 2012) that the prevalence of TB reported by Demographics and Health Surveys (DHS) is 545 per 100,000 population and ranges from 201 in the highest quintile for wealthy groups of people to 1100 in the lowest quintile for the poor and vulnerable who are indicated for TB.

Jackson et al. (2006) investigated the economic impact of the number of TB cases in rural China by using a case-control study to demonstrate the relationship between poverty and TB. The results of his research indicate that poverty is closely related to the incidence of TB even after the patient has controlled smoking habits and other risk factors. The poor can lose income when paying for TB treatment, and care (medical and non-media) directly accounts for 55.5 percent of household income in rural areas in China, and some of these poor people fall into debt to pay for TB treatment. Another result of this study is that the number of cases recovered from TB with the DOTS strategy is 91 percent, and when this DOTS strategy is incomplete or not implemented, it will increase the high mortality rate in TB sufferers. Poverty had been a significant driver in the TB epidemic. Hargreaves et al. (2011) state that poverty has led to food insecurity, malnutrition, unsuitable housing conditions, slum densely populated environmental conditions, financial, geographic, and cultural barriers to accessing health care for sufferers of TB.

The total population tends to be higher in urban areas than in rural areas. It can lead to a higher incidence of TB in areas with high population growth and urbanization in slum areas. Occurred in the 19th century on the European continent, there was a significant relationship that high levels of urbanization had resulted in population densities that tended to be vulnerable to the incidence of TB (Lönnroth et al., 2010). Another population problem from the study by Austin et al. (2016) investigated empirically 99 third world countries for the period 1995-2010 regarding TB, which has become a global health problem and a threat to development in third world countries and the results of this study indicate that high population growth rates have contributed to the high prevalence of tuberculosis among the poor. TB's problem is a substantial problem facing the urban poor and much worse than the general urban population is the case in the Philippines, a 50% higher number of TB cases than rural areas

(Tupasi et al., 2000). Structurally what determines the high risk of TB that occurs in the global community is inequality, population growth, urbanization, malnutrition, unsuitable housing conditions, which in turn will increase the risk and susceptibility to attacks from infectious diseases such as TB (Pedrazzoli et al., 2017).

The spread of TB is about medical factors and the influence of non-medical factors such as population density. The quality of the slum physical housing environment in densely populated areas can affect health, such as air vents and windows, as a medium for sunlight to enter the house, not only in rural areas but also in urban areas. Apolinario et al. (2017), in their research conducted in Portugal, found that the physical condition of a densely populated house would facilitate the incidence of TBtransmission, which would be more comfortable and faster through the air if in the house residents were suffering from TB or acid-resistant bacteria positive who accidentally cough. Mycobacterium tuberculosis that settles in the house will last up to 2 hours so that it has the possibility of transmitting TB to other family members who live in the home environment (Dotulong et al., 2015).TB cases in urban areas are closely related to high population density (Lönnroth et al., 2010; Bhunu et al., 2012). Because in densely populated urban areas, many people exposed to TB have low socioeconomic status conditions, such as malnutrition, anemia, poverty, inadequate sanitation, humid physical conditions, air ventilation, and low lighting (Janssens & Rieder, 2008).

Human resources for health are a subsystem in the national health system that has a vital role in achieving health development goals as health efforts and services (Ministry of Health, 2018). Human resources for health such as general practitioners, specialist doctors, and nurses are at the forefront of treating TB. Hariadi et al. (2009) at the health center in Bengkulu showed that human resources for health and facilities had a significant relationship with the coverage of acid-resistant bacteria-positive pulmonary TB patients. Also, research conducted in Ethiopia shows that increasing the number of health workers through the Health Extension Workers (WEH) system has shown remarkable results in reducing TB. When the WEH program was implemented for the first time, there was an increase in TB case findings from 102 to 177 cases per 100,000 population and the following year, the decrease in TB cases for acid-resistant bacteria positive to 9 percent per year and an increase in treatment from 76 percent to 95 percent after program intervention and a decrease for patients who are not followed up with treatment process from 21 percent to 3 percent (Datiko et al., 2017).

GRDP per capita is a monetary indicator for every region's population (Peterson, 2017). The income per capita approach's main success is that it focuses on the main essence of development, namely increasing people's standard and quality of life and reducing poverty. There is a significant relationship betweenincome per capita and a decrease in TB cases in the world. It is reinforced by the research of Janssens & Rieder (2008) in 2006, which examined 9 million cases of world TB. Of the number of cases, 1 percent occurred in the European Union and North American countries, and more than 65 percent occurred in African and Asian countries. This study indicates that people who have a high per capita income can reduce the incidence of TB. In 2006, Suk et al. (2009) examined the relationship between the Public Wealth Index (PWI) having a strong inverse relationship to the reduction in TB cases in 27 EU countries (including Norway and Iceland). Also, income inequality between communities in a group, the greater the incidence of TB that occurs in that group of people, because income is an indicator to compare the level of development progress or the level of community welfare. The research of Chandra et al. (2014) conducted in India in 2001-2011 showed a significant relationship in per capita income to the decrease in new TB cases per 100,000 population.

According to the Central Bureau of Statistics, the literacy rate is the proportion of the population aged 15 years and over who can read and write without understanding what they are reading or writing. The literacy rate in a region or country is a primary indicator of achievement because reading and writing are the main bases for expanding knowledge. In this study, the literacy rate is vital for the public to access health education to avoid TB transmission. Research conducted by Pratama & Wulandari (2015)

in districts/cities in West Java shows that every 1 percent increase in literacy rates will reduce the average number of TB cases by exp (0.03892) = (0.961828) ≈ 1 case with variable assumptions another constant. Chandra et al. (2014) also found that literacy rates significantly affected reducing TB cases in New Delhi, India. Health education that the community owns will influence knowledge about TB's requirements, prevention and treatment of TB, criteria for a healthy physical home environment, proper sanitation, and implementing clean and healthy living habits in the family environment and its surroundings.

## 3. MATERIALS AND METHODS

This studyusing descriptive and inferential analysis. Descriptive analysis is a statistical description that serves to describe or describe the object under study through sample or population data as it is. The descriptive analysis only provides information about the data used and cannot yet conclude the relationship between variables. Information obtained from descriptive analysis includes the presentation of data in tables and graphs, measurement of data center symptoms of the mode, median, and mean, and measurement of group variations in the form of data ranges and variances. This study's descriptive analysis was carried out using a table containing information on the standard deviation, average value, maximum value, minimum value, and variables.

**Table 1.** Description of Variables

| Variables | Abbreviation | Measurement | Source |
|---|---|---|---|
| Tuberculosis Cases | TB | The number of tuberculosis cases in 34 provinces in Indonesia | Ministry of Health |
| Poverty | POV | The number of poor people in 34 provinces in Indonesia | Central Bureau of Statistics |
| Population | POP | Thenumber of population in 34 Provinces in Indonesia | Central Bureau of Statistics |
| Population Density | DENSITY | The population density in 34 provinces in Indonesia | Central Bureau of Statistics |
| GRDP Per Capita | GRDP | GRDP per capita at 2010 constant market prices by province | Central Bureau of Statistics |
| Health Resources | HEALTH | Thenumber of health resources in 34 provinces in Indonesia | Ministry of Health |
| Literacy Rate | LITERACY | Total population aged 15 years who are literate in the year t | Central Bureau of Statistics |
| Sanitation | SANITATION | Percentage of households by province and improved sanitation | Central Bureau of Statistics |
| Toilet | TOILET | Percentage of households by province, urban-rural classification, and the owned and the use of toilet facility | Central Bureau of Statistics |

As previously described, there has been a view of the causes of tuberculosis cases in Indonesia over time. Inference analysis in this study used secondary data with the panel data method consisting of 34 provinces in Indonesia as a cross-section and time series for 13 years from 2005-2018, sourced from the Central Bureau of Statistics and the Ministry of Health. Therefore, this study uses panel data to accommodate all the characteristics of the data. Panel data is data that includes a sample of individuals over some time. In econometric theory, the process of combining time-series and cross-section data means that this category is a longitudinal panel (Gujarati dan Porter, 2009). The advantage of using

panel data is that it is more flexible in modeling differences in behavior between individuals than time-series (Baltagi, 2015).

A large amount of data increases the degree of freedom and reduces the collinearity between the independent variables, thereby increasing the econometric estimation efficiency and can be carried out an analysis that is not possible using time-series data. In general, the estimator used to analyze longitudinal panel data is OLS (Ordinary Least Square). However, there are three kinds of models in the longitudinal panel. Several tests are needed to find out the right estimator and model and test the classical assumptions. The three types of longitudinal panel data analysis models are PLS, fixed effect, and random effect. Selection of the best model used in this study using the Chow Test and Hausman Test. Chow Test is used to determine whether the model is more accurately described by the Pooled OLS model or the fixed effects model. The assumption of constant slope in the Pooled OLS model is not realistic (Baltagi, 2015). The Hausman test is a statistical test based on consideration in choosing whether to use a fixed effect or a random effect (Baltagi, 2015).

This study aims to determine whether socioeconomic and environmental factors influence the number of tuberculosis cases. Model specifications are used to provide an overview of how the model is used to answer research questions. The model used in this study is the development of previous studies. The selection of independent variables for this model is the development of independent variables that have been analyzed empirically by (Pratama dan Wulandari, 2015). The compiled linear regression equation model is as follows:

$$TB_{it} = \beta_0 + \beta_1 lnPOV_{it} + \beta_2 lnPOP_{it} + \beta_3 DENSITY_{it} + \beta_4 GRDP_{it} + \beta_5 HEALTH_{it} + \beta_6 LITERACY_{it} + \beta_7 SANITATION_{it} + \beta_8 TOILET_{it} + \varepsilon_{it} \quad (1)$$

Where $TB$ is the number of TB cases, $lnPOV$ is the natural logarithm of the number of poor people, $lnPOP$ is the natural logarithm of population, $DENSITY$ is population density, $GRDP$ is GRDP per capita at 2010 constant market price, $HEALTH$ is the number of general practitioners and nurses in hospitals and public health center, $LITERACY$ is the literacy rate, $SANITATION$ is the percentage of households that have access to proper sanitation, $TOILET$ is the percentage of households in urban and rural areas that have toilet facilities, $\beta_0$ is the intercept of the regression line, $\beta_1 - \beta_6$ is the slope of the regression line, $i$ is the number of cross-section data of 34 provinces in Indonesia, $t$ is the period of 2005-2018, $\varepsilon$ is the error term.

## 4. RESULTS AND DISCUSSIONS

The results and discussion of this research will first discuss descriptive statistics regarding the variables used. The dependent variable used was the number of tuberculosis cases. The independent variables used are the number of poor people, total population, population density, GRDP per capita, human resources for health,literacy rate, sanitation, and toilet facilities. Descriptively, the research variables can be seen in Table 2.

The number of tuberculosis cases in Indonesia in 2005-2018 had an average of 55612,271 cases. The province with the highest number of TB cases was West Java, with 99,398 cases in 2018, and the lowest was North Kalimantan, with 377 cases in 2014. TB is a disease of concern to the central and regional governments. Indonesia is a country with the second-highest number of new TB cases in the world after India. As many as 60 percent of new tuberculosis cases occurred in India, Indonesia, China, Nigeria, Pakistan, and South Africa. TB still the top 10 cause of death in the world. Referring to the Sustainable Development Goals (SDGs) target, the World Health Organization (WHO) targets to reduce deaths from tuberculosis cases by 90 percent and reduce incidence by 80 percent in 2030 compared to 2014 globally. The number of poor people in Indonesia in 2008-2015 had an average of 1014518 million people. The province with the highest number of poor people was Central Java, with 7.8 million people in 2009, and the lowest was Bangka Belitung Islands, with 30.3 thousand people in 2011. Public health

problems are closely related to poverty. Due to low-income family conditions, some people are malnourished, live in slum areas, cannot maintain their health properly, and when sick, they seek medical treatment with minimal cost, which makes them even more inadequate.

**Table 2.** Descriptive Statistics

| Variable | Obs. | Mean | Maximum | Minimum | Std. Dev. |
|---|---|---|---|---|---|
| TB | 463 | 7097.652 | 99398.00 | 337.0000 | 10904.00 |
| lnPOV | 460 | 6.236469 | 9.089528 | 3.663562 | 1.188550 |
| lnPOP | 470 | 8.286195 | 10.793309 | 6.309918 | 1.021466 |
| DENSITY | 468 | 673.7668 | 15764.46 | 2.595709 | 2423.558 |
| GRDP | 468 | 28210002 | 3.38E+08 | 469000.0 | 32949784 |
| HEALTH | 466 | 22464.59 | 1138872. | 747.0000 | 56854.70 |
| LITERACY | 300 | 93.25860 | 99.56000 | 74.88000 | 5.425874 |
| SANITATION | 268 | 60.18955 | 91.15000 | 12.93000 | 15.64046 |
| TOILET | 432 | 56.56477 | 93.41000 | 16.80000 | 15.84030 |

**Source:** Author's Calculation

The total population in Indonesia in 2005-2018 has an average of 73110235 people. The provinces with the highest population in Indonesia are West Java, with 48.6 million people in 2018, and North Moluccas, with 104.3 thousand people in 2009. The birth rate in West Java is 1.18 percent per year, and the population migration rate is high due to being the center of education and job search in several districts/cities, which are the center of industrial cities. At the same time, North Moluccas is an expansion area of Moluccas. The population is spread unevenly and is only concentrated on small islands, while the population distribution of large and medium islands did not experience a significant increase in population.

The population density in Indonesia in 2005-2018 has an average of 667,5329 people / km2. The province with the highest population density was Jakarta, with 15764.46 people/km$^2$ in 2018, and the lowest was West Papua at 2.60 people/km$^2$ in 2012. Jakarta's population density is due to the ongoing construction of housing and settlements, service companies, and industries, so that many people flock to make a living in the capital. As a result, Jakarta has become a magnet for residents of various regions to come looking for work and better livelihoods. Meanwhile, West Papua Province has a low population density due to difficult geographical conditions, long distances from one area to another, steep mountainous areas, swampy plains, fragile land, high seasonal rainfall, and low infrastructure services. It was resulting in increased costs for infrastructure development.

GRDP per capita in Indonesia in 2005-2018 has an average of IDR19815102 thousand. The province with the highest GRDP per capita was Jakarta, amounting to IDR165863.3 thousand in 2018, and the lowest was East Nusa Tenggara IDR22860.8 thousand in 2005. Family groups with low per capita income have low levels of knowledge and are prone to TB. In contrast, family groups with per capita income above the average have a good life, high knowledge, or health literacy to implement a clean and healthy residential environment, and access to health facilities is more comfortable to reach because they have insurance or pay with their cash.

The number of human resources for health in Indonesia in 2005-2018, the average value was 16252.82. The province with the highest number of human resources for health was Central Java with 149740 health workers in 2018, and the lowest was North Moluccas, with 747 health workers in 2008. Health human resources in 34 provinces, both in health centers, clinics, homes, private hospitals, general hospitals, and exceptional hospitals, are very influential in helping the success rate of TB cases in Indonesia. The literacy rate in Indonesia in 2005-2018 has an average of 93.42144. The province with the highest literacy rate was North Sulawesi at 99.56 percent in 2018, and the lowest was Papua at 74.88

percent in 2005. The high percentage of literacy rates indicates an effective education system to obtain literacy for the population aged 15 years to the top. Very useful for development programs in the health sector. Knowledge and health literacy possessed by people aged 15 years and over can help reduce TB because the community has been educated about TB prevention and transmission.

The percentage of households with access to their toilets in Indonesia in 2005-2018 had an average of 56.56 percent. The province with the highest access to self-owned toilets was East Kalimantan at 91.76 percent in 2017, and the lowest was Gorontalo at 28.83 percent in 2006. The percentage of households with access to proper sanitation in Indonesia in 2005-2018 had an average of 60.18 percent. The province with the highest access to proper sanitation was Bali at 91.15 percent in 2018, and the lowest was East Nusa Tenggara, 12.93 percent in 2014. Environmental factors such as the availability of proper sanitation and toilets are essential for environmental health. The spread of TB germs, one of which can be suppressed by proper sanitation, from house lighting that is exposed to sunlight, floors and walls that are not damp, smooth air ventilation, residents of the house are not congested and toilets that are used only for members of the house themselves, not for the public.

### *4.1. Panel Data Analysis Result*

Table 3 shows the Chow and Hausman test results to determine the best model estimate used in this study. Chow test results, the value of Prob. Cross-section of chi-square < α or 0.0000 <0.05. While the Hausman test results, the value of Prob. Cross-section Random < α or 0.0050 <0.05. Based on the Chow and Hausman test results, the best model used to estimate panel data in this study is the fixed effect model (FEM).

**Table 3.** Chow and Hausman Test

| **Chow Test** | | | |
|---|---|---|---|
| | Statistic | Prob. | Conclusion |
| Cross-section Chi-square | 527.112601 | 0.0000 | fixed effect model (FEM) |
| **Hausman Test** | | | |
| | Chi-Sq. Statistic | Prob. | Conclusion |
| Cross-section random | 23.819893 | 0.0050 | fixed effect model (FEM) |

**Source:** Author's Calculation

**Table 4.** The Estimation Result of Fixed Effect Model

| **Dependent variable:** TB | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. Error** | **t-Statistic** | **Prob.** |
| lnPOV | 0.081645 | 0.140253 | 2.582127 | 0.0627** |
| lnPOP | 0.371419 | 0.468377 | 2.792991 | 0.0309** |
| DENSITY | 0.197716 | 1.679164 | 2.117746 | 0.0667** |
| GRDP | -4.52E-02 | 1.96E-02 | -2.306762 | 0.0245** |
| HEALTH | -0.027257 | 0.010592 | -4.573400 | 0.0126** |
| LITERACY | -0.396521 | 18.38094 | -2.021572 | 0.0829*** |
| SANITATION | -0.137315 | 4.488668 | -0.030592 | 0.9757 |
| TOILET | -1.561379 | 10.90690 | -0.143155 | 0.8866 |
| Constant | 3173.143 | 19412.19 | 1.743461 | 0.0707* |
| R-squared | 0.999032 | | F-statistic | 1547.475 |
| Adjusted R-Squared | 0.998386 | | Prob(F-statistic) | 0.000000 |

**Note:** *, *, and*** indicate significance at 10%, 5%, 1%, respectively.
**Source:** Author's Calculation

Table 4 show the results of parameter estimation showing the effect of socioeconomic and environmental factors on the number of TB cases have an R-squared value of 99.90% and an Adjusted R-squared of 99.83%. Furthermore, the F-Statistic is 1547,475 and significant at 1 percent. The results of this study indicate that all independent variables have a significant effect on the dependent variable.

*4.2. Discussions*

Figure 3. shows the spatial distribution of the number of TB cases in Indonesia during the thirteen years of this study. It can be seen that the highest number of TB cases is in Java Island, namely West Java with an average number of TB cases during 2005-2018 as many as 42,909 cases, East Java with 29,589 cases, Central Java with 24,946 cases, Jakarta with 13,804 cases, and Banten with 10,264 cases.Meanwhile, provinces outside Java Island with the highest average TB cases were North Sumatra with 32,630 cases and South Sulawesi with 10,009 cases. These numbers continue to be of concern to the government, and the community also has a vital role in helping prevent TB by continuing to carry out health checks at the nearest hospital and public health center.

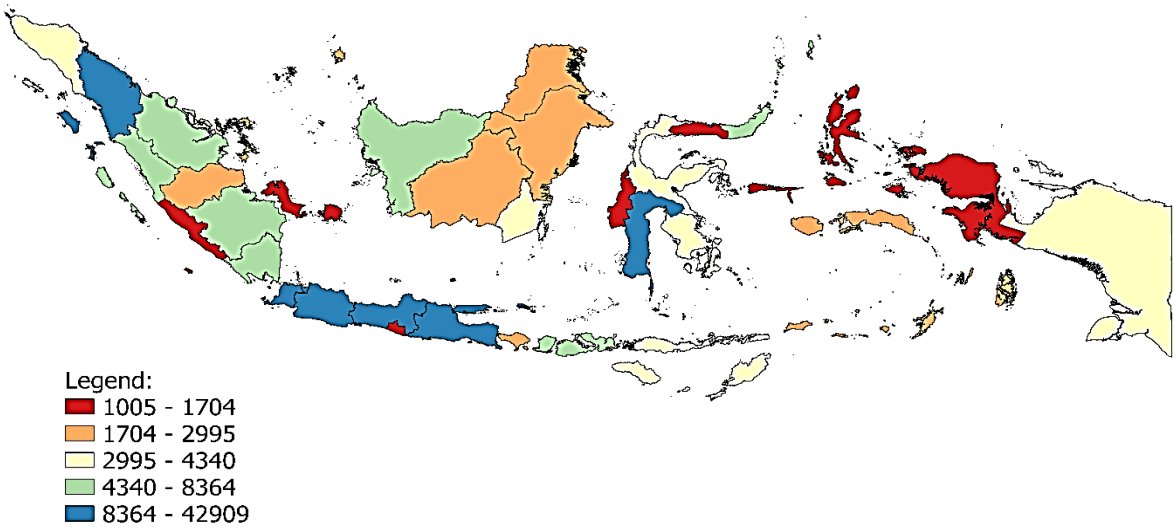


**Figure 3.** Distribution of Average Number of TB Cases in Indonesia, 2005-2018
**Source:** Author's Calculation

Based on the model's estimation results in this study (see Table 4), the number of poor people has a positive and significant effect on Indonesia's number of TB cases. In line with research conducted by Jackson et al. (2006), Oxlade & Murray (2012), Bhunu et al. (2012), Wong et al.(2013) stated that poverty is closely related to TB cases. There tend to be many tuberculosis cases in countries or regions with many poor peoplethan other countries or regions. TB is still a significant health problem in the world and in Indonesia. Indeed, now there is a DOTS program to tackle TB, but it does not cover all TB sufferers. Acceleration efforts need to be made so that DOTS can be appropriately implemented in all regions of the world, especially in Indonesia, ranked 3rd with the most TB cases in the world. Whether we realize it or not, TB is the giant poverty producing mechanism. Diluting TB in one country is the same as allowing poverty to run rampant in that country. The government wants to get around sufficient health funds, so even though it seems that a large amount of foreign exchange is coming out in the future, there will be savings due to controlled TB. The World Health Organization (WHO) states that Indonesia's TB treatment program has a benefit-cost ratio of 55:1. Every $1 a country spends on TB programs will provide $55 in Indonesia's benefits over the next 20 years. The World Bank states that DOTS is a very cost-effective

health strategy. Addressing TB and poverty requires a strong political commitment, supported by the wider community's participation, of course, among those who work in the health sector.

The total population has a positive and significant effect on the number of TB cases in Indonesia. In line with the study conducted by Tupasi et al. (2000), Lönnroth et al. (2010), Austin et al. (2016) said that the higher the population of a country or region, the higher the number of TB cases.The population density variable has a positive and significant effect on TB cases in Indonesia. In line with the research of Lönnroth et al. (2010), Bhunu et al. (2012), Apolinario et al. (2017), Rodrigues et al. (2017) state that population density and mobility are high so that the risk of transmitting the spread of TB is high.The high population and population density and high social inequality of TB control in big cities have become a global challenge to date. The incidence of TB is closely related to vulnerability to social determinants, such as HIV co-infection, drug use, immigration, unemployment, low education levels, slum quality, and densely populated areas. These overlapping problems provide strong evidence that the number of TB cases is increasing.

Based on the 2015 Intercensal Population Survey (SUPAS), Indonesia's population reaches 225 million. The Central Bureau of Statistics projects this population to increase to 271 people in 2020 to reach 305 million in 2035. West Java is the province with the largest population, with 49.9 million in 2020 and 57.1 million in 2035. In second place and East Java and Central Java, respectively, the population is projected to reach 39.8 million and 34.9 million in 2020. Meanwhile, North Sumatra, South Sulawesi, South Sumatra, and Lampung are provinces outside Java, which consistently rank in the top 10 as the province with the largest population since 1971. Population density based on data from the Central Bureau of Statistics shows six provinces with the highest population density in Indonesia. Jakarta is in first place with a population density of 15.764 people/$km^2$, West Java with a population density of 1.376 people/$km^2$, and Banten with a population density of 1.313 people/$km^2$. Referring to data and information on Indonesia's Health Profile in 2018, there were 566,623 cases, an increase compared to all TB cases found in 2017, which amounted to 446,732 cases. The highest number is in provinces with a high population and population density, namely West Java, East Java, and Central Java. TB cases in these three provinces account for 44% of the total number of cases in Indonesia. Based on these data, according to the results of this study, high population size and population density can increase the number of cases of transmission of respiratory diseases such as TB with droplet transmission because the chance of contact with TB sufferers will be greater

The GRDP per capita has a negative and significant effect on the number of TB cases in Indonesia. In line with a study conducted by Janssens & Rieder (2008); Suk et al. (2009); Lönnroth et al. (2010); Liu et al. (2012); Chandra et al. (2014); De Castro et al. (2018); Mahara, Yang, Chen, Wang, & Guo (2018) stated that the high income per capita of the population of a country or region would affect the socioeconomic conditions of life.Economic growth is an essential factor for increasing living standards( Headey & Hoge, 2009; Kustanto, 2020a). The more prosperous a person's life is, the more affordable access to health facilities will be due to their resources when they are sick. Household economic status is an essential factor in improving health status because TB has been established as an infectious disease closely related to poverty (Wubuli et al., 2015). GRDP per capita increases, the incidence of TB cases will decrease. This evidence confirms that a lower per capita income is a predictor of TB occurrence. In recent years, Indonesia has experienced rapid economic development and urbanization, with an average per capita income of IDR59.1 million in 2019, increasing compared to 2018 IDR56 million. Provinces in Java Island still dominate economic growth contributed 59% to GDP, Sumatra Island 21.32%, Kalimantan Island 8.05%, Sulawesi Island 6.33%, and the remaining 5.3% in other islands. This contribution, the entire archipelago, has experienced growth, except for Moluccas and Papua, which experienced a contrast of 7.4% in 2019.

The human resources for health have a negative and significant effect on the number of TB cases in Indonesia. In line with research conducted byHariadi et al. (2009) & Datiko et al. (2017) said that

health resources are very influential in helping the successful treatment and reduction of TB. Furthermore, this study's results are not in line with the study results by Shi, Guo, & Sun (2017). This explanation could be that the regions used in this study are 34 provinces in Indonesia, while the Shi, Guo, & Sun (2017) study covers all geographic areas in China. A quality and easily accessible public health care system will result in a reasonable degree of health in the country. Human resources for health are an essential part of TB patients. Because the treatment provided by human resources for health is quite long and expensive, patients must have access to free medical services such as the nearest public health center through coordination with the World Health Organization (WHO).

The literacy rate has a negative and significant effect on the number of TB cases in Indonesia. From a public health perspective, literacy rates are an essential variable to explain the prevalence of good and bad health. In line with the results of research by Chandra et al. (2014); Pratama & Wulandari (2015) said that the population of a country or area that has a population with a high literacy rate would influence daily life in implementing a clean and healthy lifestyle which is useful in preventing and transmitting incidents of TB. Another finding from this study is the environmental factor of the availability of proper sanitation and private toilet facilities for householdshave a negative but insignificant relationship to the number of TB cases in Indonesia. This study indicates that if households in Indonesia can increase ownership of access to proper sanitation and toilet facilities, it can reduce the number of TB cases. If not, poor sanitation and toilet facilities can transmit TB to the population living there (Mariana et al., 2020).

### *4.3. The Ending TB in Indonesia*

Tuberculosis was the top 10 cause of death in the world in 2015. Of the 10.4 million people who suffer from TB, 1.2 million people also have HIV. In the same year, there were 1.8 million people who died from TB, and 0.4 million had HIV. After theMillenium Development Goals (MDGs) era ended in 2015, TB was still in the world spotlight because it had not been 100% resolved. In the SDGs era, especially goal number 3 related to health, ensuring a healthy life, and promoting welfare for all ages.

Furthermore, the emphasis is on stopping the epidemics of AIDS, TB, malaria, and other tropical diseases. The TB incidence itself is targeted to be reduced by 80% and 90% for the death ratio due to TB. This target is expected to be achieved by 2030 (World Health Organization, 2015). The World Health Organization (WHO) with the End TB Strategy targets reducing TB incidence and mortality ratio by 90% and 95% by 2035, 5 years longer than the end of the SDGs era(Uplekar et al., 2015).

World Health Organization (WHO) strategy aligns with the Sustainable Development Goals(SDGs), especially in eradicating TB.With the various kinds of interventions carried out, this target can reduce the incidence and mortality ratio due to TB by up to 100%.Another critical health target is to achieve universal health coverage, including access to financial risk protection; access to safe, effective, and quality health services; affordable medicines, and vaccines for all people. The success in early detection and therapy in TB is one indicator of achieving these targets.

To end the TB problem in Indonesia, I have several notes related to TB infection control services, which are as follows:

- Services for controlling Tb infection (formerly known as latent TB) are generally provided in areas with a low TB epidemic rate. Treatment of people with TB infection and a high risk of developing TB disease has long roots in wealthy countries, where early detection and treatment systems have managed to keep TB epidemic rates relatively low.
- As one of the countries with a high TB epidemic rate, Indonesia, apart from still struggling hard to strengthen thefind, treat up till cured (TOSS) for TB disease. It is necessary to prepare to strengthen the national TB infection treatment service system shortly to significantly reduce incidence by 2035 and end the TB problem with a TB incidence rate of one per million.

- With the family approach, there is an opportunity not to separate the TB service approach for adults from services for children and adolescents. It can also strengthen a more comprehensive tuberculosis control system, which is not only focused on TB disease TOSS, but also efforts to promote, prevent, and control tuberculosis infection.
- We need to review all scientific studies on the TB problem in Indonesia, strengthen clinical and epidemiological research and service systems, and operational research (implementation), including collaborative research through the newly formed TB Research Network.
- Every innovation can be a new diagnostic method, a new type of drug; it is better if it is still operational research or implementation research to be studied more deeply before it is widely implemented.

## 5. CONCLUSIONS

The threat of TB is still happening in the world. In 2018, 10 million people worldwide suffered from tuberculosis, and 1.5 million people died from this contagious disease. Referring to target 3 Sustainable Development Goals (SDGs), goal 03 regarding good health and welfarethat by 2030, end the epidemic of AIDS, TB, malaria, and other tropical diseases and fight hepatitis, water-borne diseases, and other infectious diseases. Based on data from the World Health Organization (WHO), Indonesia ranks 3$^{rd}$ for TB cases globally. The estimated population suffering from TB is 845,000 cases; only 68 percent of cases were found and treated in 2018. The high number of TB cases in Indonesia could threaten the golden generation opportunity in the next 2025 demographic bonus, where the number of productive age population is greater than the total populationnon-productive age.

Medical factors do not only cause TB cases; non-medical factors include influencing TB. This study shows that socioeconomic and environmental factors influence the number of TB cases. The total population, population density, and the number of poor people show a negative and significant effect on Indonesia's TB cases. In contrast, GRDP per capita, healthresources, and literacy rates show a negative and significant effect on Indonesia's number of TB cases. Furthermore, for environmental factors, proper sanitation and ownership of toilet facilities show adverse but insignificant effects on Indonesia's TB cases.The high income of a population will increase the welfare of life and better access to health, education, and purchasing power. Also, the increasing number of health resources will make it easier for people to get treatment, knowledge, and socialization about TB so that prevention can be maximized and new TB cases can be reduced. A country or region's literacy ratedramatically determines its people's health literacy because of high literacy skills. This can help to reduce the risk of transmitting TB.

This study's findings show that population factors have influenced the increasing number of TB cases in Indonesia. Therefore, controlling the rate of population growth, high population density, and poverty must be the focus of the government to reduce new cases of TB with family planning programs, transmigration programs to areas with low population density, and increase social assistance for the poor and the poorto be able to improve his standard of living. The health infrastructure budget must also be increased, and the economy remains competitive and maintained, and investment in human capital continues to be increased. This study's analysis's limitation is the short period, namely 2005-2018, and uses macroeconomic data. It is hoped that for further research, the model will continue to be refined using household microeconomic data in Indonesia, such as the Basic Health Research (Riskesdas) so that the resulting analysis is best.

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