



SPATIAL ANALYSIS OF TUBERCULOSIS INCIDENCE TRENDS AND ENVIRONMENTAL DETERMINANTS IN DEPOK CITY IN 2022-2024

Muhammad Baskoro^{a*} ; Artha Prabawa^b ; Zanastia Sukmayanti^c

^{a,b} Magister Program, Department of Biostatistics and Demography, Faculty of Public Health, University of Indonesia, Depok and 16424, Indonesia

^c Public Health Program, Faculty of Health Sciences, UIN Syarif Hidayatullah Jakarta, South Tangerang and 15412, Indonesia

Abstract

Tuberculosis (TB) remains a major public health problem in Indonesia and globally. TB is transmitted through airborne droplets inhaled from individuals with active TB. Transmission risk increases in densely populated areas, poor ventilation, and settings with high social interaction, such as Depok City. Persistently high TB prevalence reflects challenges in treatment success and community-based prevention. This study aims to analyze trends and spatial patterns of TB incidence in Depok City from 2022 to 2024 and their relationship with population density and hand washing behavior with soap (HWWS). A spatial descriptive study was conducted using secondary data on TB cases and HWWS from the Depok City Health Profile, and population density data from Depok City in Figures (2022–2024). TB cases were concentrated in districts with high population density, particularly Tapos, Sukmajaya, Pancoran Mas, and Cimanggis. HWWS showed no clear spatial association with TB incidence. Population density was identified as the main determinant of TB distribution in urban areas. Therefore, region-based TB control strategies supported by spatial analysis are needed to improve intervention prioritization and effectiveness.

Keywords: *Tuberculosis; Spatial; Population Density; Hand Washing Behavior With Soap*

1. Introduction

Tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis*, an acid-fast bacillus transmitted through the air (airborne) and mainly affecting the lungs (WHO, 2025a). Transmission occurs when healthy individuals inhale droplets or aerosols containing bacteria from people with active TB, especially in poorly ventilated environments with high population density (Kemenkes, 2025a). The risk of transmission increases significantly in densely populated environments, enclosed spaces, poor ventilation, and high intensity of social interaction (Imalia, 2025; Deol et al., 2022; Issarow et al., 2018). The chronic nature of TB causes progressive damage to lung tissue and can reduce the quality of life of patients if not treated appropriately.

Globally, TB remains one of the leading causes of morbidity and mortality from infectious diseases. In 2024, TB caused approximately 1.23 million deaths worldwide, with the highest burden in Southeast Asia and the Western Pacific (WHO, 2024). In 2024, the highest number of new TB cases occurred in the Southeast Asia region (34%), followed by the Western Pacific region (27%) and the African region (25%) (WHO, 2025). Asia accounts for the largest proportion of global TB cases, particularly in developing countries with high population density, inadequate housing conditions, and unequal access to healthcare. In 2023, three countries accounted for more than two-thirds of global TB cases, namely India (26%), Indonesia (10%), and China (6.8%) (WHO, 2025). Indonesia is one of the countries with the highest TB burden in the world and consistently ranks among the top three countries with the highest number of TB cases. The high national TB burden reflects significant challenges in case detection, treatment success, and community-based prevention strategies.

*) Corresponding Author (Muhammad Baskoro)

E-mail: baskoro.workspace@gmail.com

West Java Province in 2024 was one of the regions

with the highest number of TB cases in Indonesia, with 233,334 new TB cases or 22% of the national total (Pemprov Jawa Barat, 2024). Depok City, as an urban area experiencing rapid population growth, has TB among the top 20 diseases in community health centers and hospitals (Profil Kesehatan Kota Depok 2024). The dynamics of urbanization in Depok have led to the growth of densely populated settlements, unequal access to health services, and high socioeconomic heterogeneity. These conditions create an environment conducive to TB transmission, especially in areas with high population density. In addition, community behavior in disease prevention, including the practice of HWWS behavior. Although HWWS does not directly play a role in interrupting airborne TB transmission, it reflects the level of clean-living behavior and health awareness of the community, which can influence susceptibility to infectious diseases in general.

TB is categorized as a dangerous disease because it causes high morbidity and mortality, but also because of its potential for rapid transmission within communities. Clinically, TB can cause lung tissue damage, decreased respiratory function, and serious complications such as massive hemoptysis and respiratory failure (Kemenkes 2025a; Mohidem et al., 2021). Socioeconomically, TB places a financial burden on families due to lost productivity and long-term treatment costs. The emergence of drug-resistant TB adds to the complexity of treatment because it requires longer, more expensive therapy with lower success rates. Therefore, TB is a multidimensional public health problem that requires a comprehensive approach that considers biomedical, behavioral, and physical environmental factors.

Environmental factors, particularly population density, are one of the main determinants of TB incidence. Overcrowded housing with poor ventilation prolongs the presence of *Mycobacterium tuberculosis* in the air, thereby increasing the risk of exposure to infectious droplets (Kemenkes, 2025a; Faizal & Pangesti, 2021; Martias & Sitanggang, 2018). Other environmental variables such as housing quality, sanitation, and education levels also influence an individual's risk of exposure and developing active cases. HWWS behaviors, while not directly preventing TB transmission, play a role in improving personal hygiene and preventing other infectious diseases that can weaken the immune system. HWWS behaviors can also be an indicator of broader health behaviors and reflect a household's ability to practice a clean lifestyle.

Spatial analysis using Geographic Information Systems (GIS) is an important method for understanding the spread of infectious diseases such as TB. GIS enables the visualization of case distribution geographically, the identification of clusters, and the study of changes in spread patterns over time (TechnoGIS, 2024). The use of GIS can strengthen area-based TB control approaches and enable policymakers to determine more effective intervention priorities. Examining trends in TB spread patterns over time is important because it can provide an overview of changes in regional risk and the effectiveness of TB control efforts that have been carried out. Changing spread patterns may indicate shifts in environmental or behavioral risk factors, while consistent patterns may indicate areas that require long-term intervention. Although various studies have shown a correlation between population density and TB incidence, studies analyzing spatial trends in TB while considering public health behavior indicators such as HWWS at the city level are still limited, especially in the Depok City area. Therefore, this study aims to analyze the trends and spatial patterns of tuberculosis incidence in Depok City from 2022 to 2024 and their association with population density and HWWS as environmental and behavioral determinants.

2. Method

The analysis was conducted using a spatial descriptive approach to map the distribution of TB cases and their relationship with population density and HWWS. The research location was in Depok City, West Java Province, consisting of 11 subdistricts. The research was conducted from November to December 2025. All data used in this study were secondary data obtained from the Depok City in Figures (2022–2024) report to determine population density and the Depok City Health Profile (2022–2024).

Spatial data was processed using QGIS software with subdistrict analysis units. Then, TB categorization, population density, and HWWS were carried out using the Natural Breaks (Jenks) method. The method in the QGIS feature resulted in 5 categories, namely, category 1 indicating a very low severity level, and category 5 indicating the opposite. The natural breaks method was chosen because it can group data based on similarities, meaning that variation within the group is minimal even though the values between points differ. The results of this study are expected to identify priority areas for intervention so that TB control programs can be implemented more effectively and efficiently, providing new insights into spatial trend analysis that is not only descriptive but also provides strategic value for health policymakers

to support national efforts towards TB elimination. This study used aggregated secondary data without individual identities, so it did not require ethical approval.

3. Result and Discussion

TB with Population Density

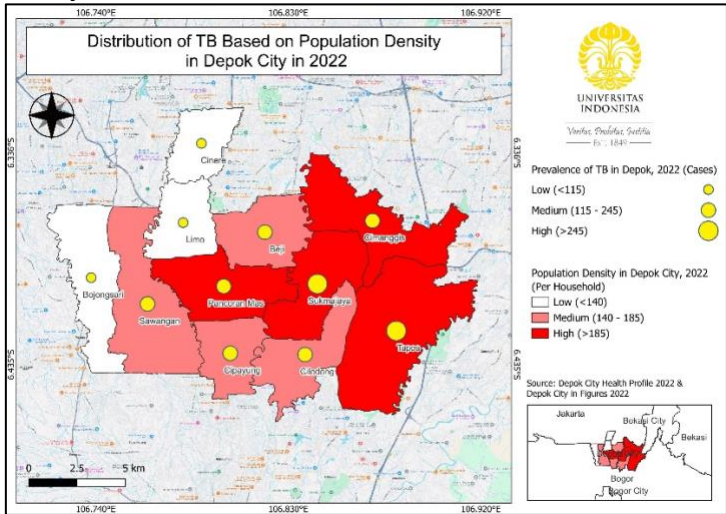


Figure 1. Distribution of TB Based on Population Density in Depok City in 2022

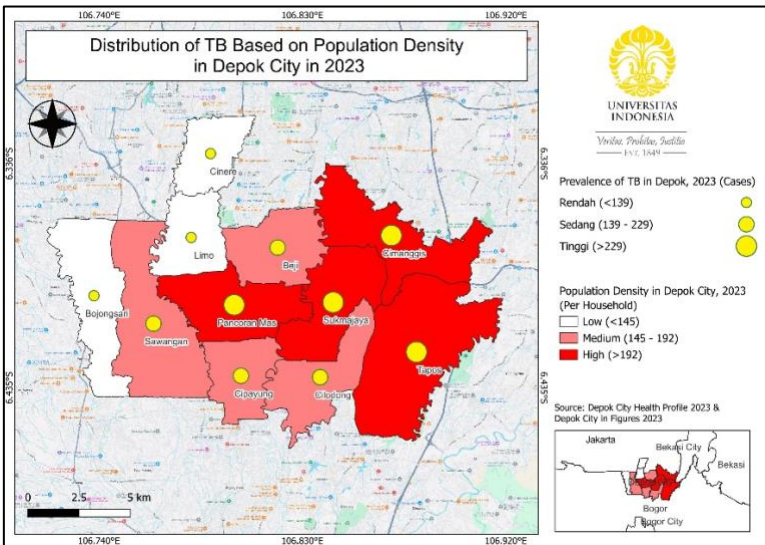


Figure 2. Distribution of TB Based on Population Density in Depok City in 2023

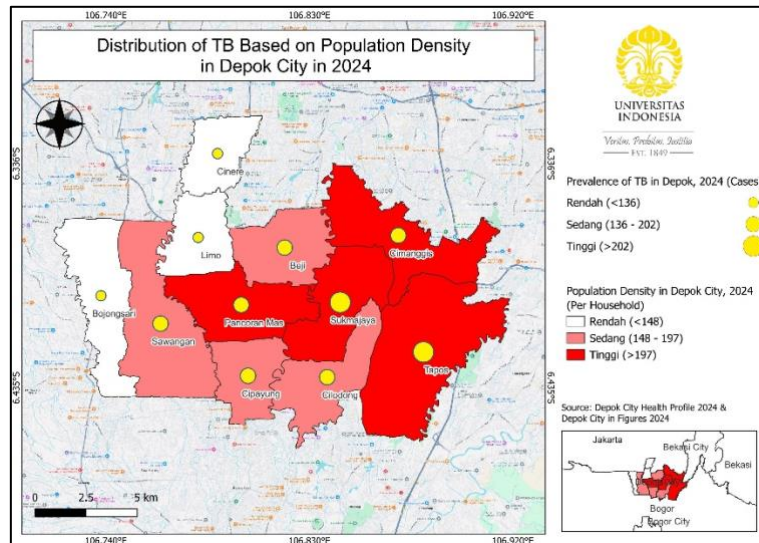


Figure 3. Distribution of TB Based on Population Density in Depok City in 2024

Spatial analysis results show a clustering pattern between population density and TB prevalence in Depok City during the 2022–2024 period. Areas with high population density were consistently identified in the subdistricts of Tapos, Sukmajaya, Pancoran Mas, and Cimanggis, as indicated by the dominance of red on the population density map. The consistency of this pattern over the three years of observation indicates that the distribution of the population in these areas is relatively stable and reflects the characteristics of urban areas with high social activity and population mobility. Overall, the number of TB cases in Depok City fluctuated during the 2022–2024 period, with an increase in 2023 and a decrease in 2024. The distribution of cases was uneven and tended to be concentrated in certain subdistricts.

Based on spatial analysis, TB prevalence shows a tendency to be associated with population density. In 2022, subdistricts with high population density, particularly Tapos and Sukmajaya, showed higher TB prevalence compared to other areas. Conversely, subdistricts with low population density, such as Bojongsari, Limo, and Cinere, consistently had lower TB prevalence. This pattern indicates that population density plays a role as an environmental factor that increases the chance of TB transmission, possibly through high intensity of contact between individuals and more crowded living conditions.

In 2023, the spatial pattern of TB prevalence did not show significant changes, with TB cases still concentrated in the same subdistricts with high population density, namely Tapos, Sukmajaya, Pancoran Mas, and Cimanggis. However, in aggregate, there was an increase in the TB burden at the city level, as reflected in the shift in the lowest prevalence category from <115 cases in 2022 to <139 cases in 2023. This increase may reflect an increase in transmission, improvements in case detection and reporting systems, or a combination of both.

In 2024, the spatial distribution of TB again showed a concentration of cases in densely populated areas, confirming the persistence of the spatial pattern of TB for three consecutive years. Overall population density increased from 2,123,350 inhabitants in 2023 to 2,145,400 inhabitants in 2024. However, overall TB prevalence in 2024 decreased compared to 2023, as indicated by a decrease in the lowest prevalence category from <139 cases to <136 cases, with TB prevalence in 2023 at 2,486 cases and decreasing in 2024 to 2,431 cases. This decline indicates the potential positive impact of TB control efforts, although it is not yet strong enough to change the basic spatial pattern influenced by population density. The persistence of TB cases in subdistricts with high population density indicates that these areas have the potential to become TB *hotspots* that require priority intervention.

TB with Handwashing behavior with Soap

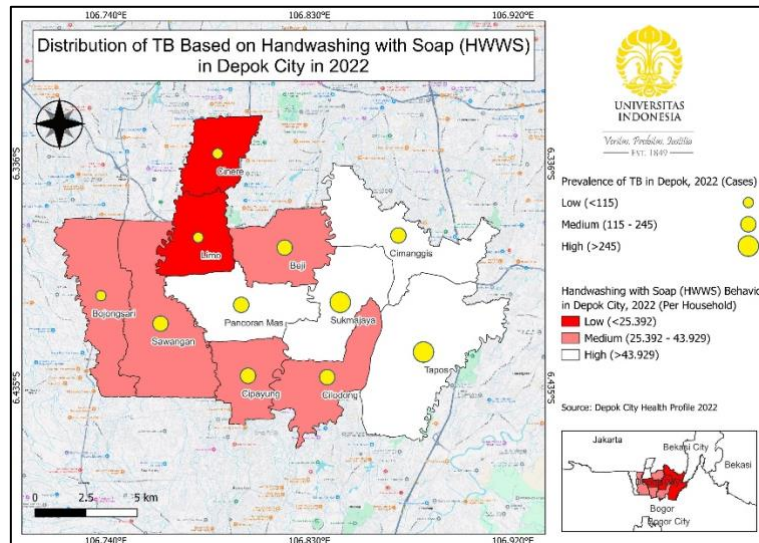


Figure 4. Distribution of TB Based on Handwashing with Soap in Depok City in 2022

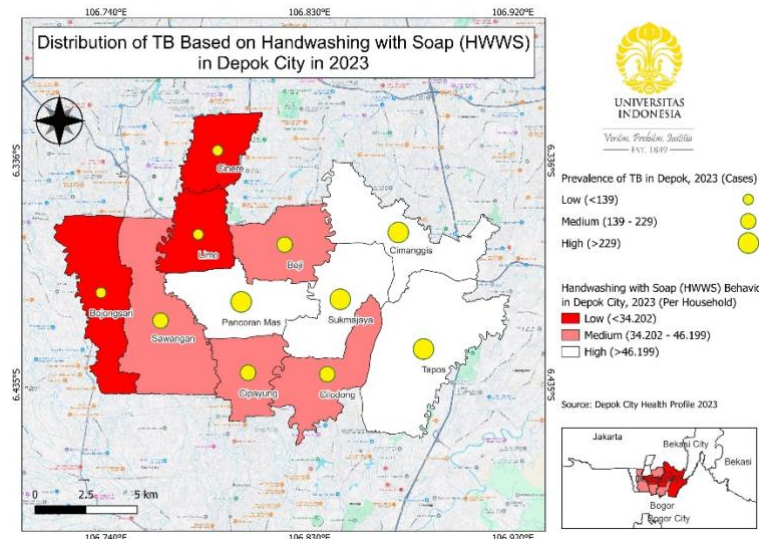


Figure 5. Distribution of TB Based on Handwashing with Soap in Depok City in 2023

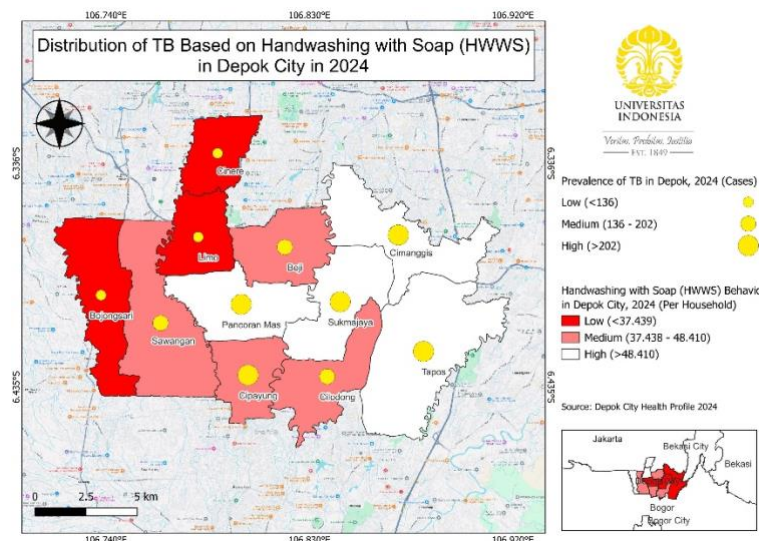


Figure 6. Distribution of TB Based on Handwashing with Soap in Depok City in 2024

The spatial analysis results show an unrelated pattern between TB prevalence and HWS

distribution in Depok City during the 2022–2024 period. In general, areas with low to moderate HWWS coverage tend not to be associated with TB prevalence. This can be seen from the distribution of TB cases, where TB cases are higher in areas with high HWWS behavior compared to areas with low HWWS behavior. On the 2022 map, TB cases in the Limo and Cinere subdistricts were lower than in the Tapos and Sukmajaya subdistricts, which had high HWWS behavior categories. Areas with high TB cases are indicated by larger circles, which become smaller as the prevalence category decreases. Low HWWS behavior is indicated by red on the subdistrict map and changes to white as HWWS behavior increases.

In 2023, the spatial pattern of the relationship between HWWS and TB remained relatively consistent in the subdistricts of Tapos, Sukmajaya, Cimanggis, and Pancoran Mas. Although there was an increase in the implementation of handwashing with soap, as can be seen in the lowest category, where in 2022 the lowest category was <25,392 and in 2023 the lowest category increased to <34,202. The pattern in 2023 continues to show that subdistricts with low to moderate HWWS coverage still have a lower prevalence of TB compared to subdistricts with high HWWS coverage. This indicates a lag effect between improvements in HWWS behavior and its impact on reducing TB incidence.

In 2024, the spatial map again shows that TB prevalence is still high in the subdistricts of Tapos, Sukmajaya, Cimanggis, and Pancoran Mas, which have high HWWS coverage. However, various regions still show relatively high TB prevalence even though HWWS coverage has begun to increase. For example, Tapos subdistrict had 72,044 HWWS applications per family card in 2023, increasing to 77,271 in 2024. This indicates that TB is a multifactorial disease, so improving HWWS alone is not sufficient to quickly change the pattern of TB case distribution.

Spatial analysis shows that the distribution of TB cases in Depok City during 2022–2024 was uneven across subdistricts. In 2022, TB cases tended to occur in areas with dense settlements and inner-city areas, such as several subdistricts, namely Tapos, Sukmajaya, Pancoran Mas, and Cimanggis. This pattern continued in 2023, with a strengthening of clusters or grouping in the same areas and a slight expansion to surrounding subdistricts. Spatial comparisons between years show that several subdistricts consistently had TB cases, indicating the possibility of persistent environmental risk factors, such as population density, inadequate housing conditions, and poor community hygiene practices. These findings are in line with Siregar's (2019) research, which shows that TB clusters tend to remain in areas with social and environmental determinants. This pattern reflects that even though TB control programs have been implemented, environmental influences and community behavior remain important determinants that maintain TB clusters from year to year.

Spatial trend analysis shows consistent patterns from year to year in several locations, indicating the persistence of environmental risks. Conversely, in 2024, new clusters emerged in several subdistricts that previously did not show a high TB burden, possibly due to changes in population density, new residential development, or increased case reporting. The emergence of these new clusters is consistent with the findings of Damayanti's (2024) research, which explains that the dynamics of urbanization and increased case detection can give rise to new TB clusters even in areas that were previously low risk.

The overlay of TB maps and population density maps shows that there is a correlation. Most subdistricts in the highest density category also have a high number of TB cases compared to other areas. This trend has been consistent from 2022 to 2024, although there has been a slight variation in the location of new clusters in areas with dense residential development. This spatial pattern reinforces the understanding that densely populated environments provide conditions conducive to the transmission of *Mycobacterium tuberculosis*, particularly through aerosol transmission in enclosed spaces (Fadhillah, 2023; Gultom et al., 2022). In addition, densely populated areas usually have inadequate ventilation, increasing the likelihood that infectious droplets will remain in the air for longer (Nurrizki, 2021). These results are consistent with studies by Danuartha et al. (2021) and Wedhaswari (2025), which consistently report that housing density and poor ventilation increase the risk of TB transmission through increased frequency and duration of close contact. Epidemiologically, the relationship between population density and TB has been widely reported in global and national studies. Dense housing increases contact between individuals, especially in confined spaces such as rented houses, boarding houses, and cramped settlements. Research by Alhawaris and Tabri (2020) explains that the duration of exposure in densely populated housing increases the chance of latent infection developing into active TB. These conditions prolong exposure to infectious droplets, thereby increasing the risk of TB transmission. Population density is one of the strongest determinants in the spread of TB, especially in developing urban areas. A similar conclusion was also presented by the WHO (2025), which emphasized that population density is a dominant factor in urban TB epidemiology.

The spatial map of HWWS behavior shows variations between regions, with some subdistricts having excellent HWWS coverage, while other regions have lower coverage. Subdistricts with low HWWS coverage are generally located in areas with inadequate sanitation or lower levels of education (Siregar et al., 2025b). An overlay of the TB map and the HWWS map shows that not all areas with low HWWS have high TB cases, as some subdistricts with high TB cases have high HWWS coverage. This pattern shows that the relationship is not as strong as the relationship between TB and population density, even though HWWS is one of the measures to prevent TB as stated in the Find and Treat Tuberculosis Until Cured program by the Ministry of Health (Kemenkes, 2019). HWWS is one of the signs of implementing clean and healthy living behaviors where washing hands can kill microorganisms on the hands and prevent the spread of infectious diseases (Marzuki and Tahrim, 2024). During the 2022–2024 period, several subdistricts showed a pattern of no correlation between low HWWS coverage and TB cases. This is in line with research by Nurhayati et al (2022) and Siregar et al (2019), which states that HWWS serves as an indicator of health behavior and infection prevention in general, although it does not directly stop TB transmission. HWWS is not a direct determinant of TB transmission because TB is transmitted through the air, but HWWS behavior serves as an indicator of household sanitation and clean living habits that influence the occurrence of other infections that can weaken the immune system. Individuals with low immunity are at greater risk of developing active TB after exposure to bacteria (Alhawaris, 2020). Thus, HWWS can serve as a *proxy indicator* of public health behavior relevant in the context of TB risk.

The integration of the two variables shows that the subdistricts of Tapos, Sukmajaya, Pancoran Mas, and Cimanggis still have the highest TB cases in Depok City, consistently from 2022 to 2024. This category of areas is a priority for intervention because it presents a double risk: a physical environment that supports airborne transmission and suboptimal public health behavior. Meanwhile, subdistricts with high density and high HWWS still show TB cases. This indicates that healthy behavior can slightly reduce the risk, although it does not eliminate the threat of disease in dense environments, and population density is a dominant factor in TB transmission in urban areas (Al Muchtary and Fatarona, 2023). These findings are consistent with Ramadhani's (2022) research, which confirms that behavioral interventions have limited protective effects if structural determinants such as density and housing quality are not addressed.

Depok is a city undergoing rapid urbanization. This contributes to TB spread patterns influenced by housing quality, community mobility, and health behaviors. These findings align with Depok's characteristics as a city with dense settlements in several subdistricts, as well as increasing vertical housing and boarding houses that result in close contact between individuals. The consistency of these results with Damayanti's (2024) urban TB research reinforces the scientific explanation that urbanization without environmental improvements increases TB vulnerability. The findings from this spatial analysis provide a strong basis for determining priority areas in TB control programs. Areas with a combination of high density and low to moderate HWWS should be the focus of interventions, namely, active TB screening based on the area, education on clean and healthy living behaviors, improvement of ventilation in densely populated housing, strengthening of the public health center surveillance network, and HWWS campaigns that are contextual to the needs of the area. Additionally, integrating GIS into TB programs is highly recommended for monitoring risk changes and evaluating intervention effectiveness on an ongoing basis.

4. Conclusion and Suggestion

Spatial analysis of TB in Depok City from 2022 to 2024 shows that the distribution of TB cases is uneven and tends to form consistent clusters in subdistricts with high population density, particularly Tapos, Sukmajaya, Pancoran Mas, and Cimanggis. Although there was an aggregate decrease in the number of TB cases in 2024, the spatial pattern of TB incidence did not change significantly, indicating that risk clusters remained with the same pattern as in the previous year. Population density has been shown to have a strong spatial association with TB incidence, while HWWS acts as a preventive factor that reflects the level of community health vulnerability, although it is not a direct determinant of TB transmission. These findings confirm that the dense urban physical environment is a dominant factor in maintaining the TB burden from year to year, despite various control efforts. This analysis used aggregated data per subdistrict in Depok City for 2022–2024, which has limitations in describing individual variations. Other variables such as socioeconomic status, nutritional status, HIV, and household *overcrowding* were not analyzed in this study and therefore cannot be used to draw causal conclusions. Additionally, the early 2022 period was a transition phase from the COVID-19 pandemic to a recovery period, which impacted the

health system, community behavior, and the dynamics of infectious disease spread. During this period, the health surveillance system experienced fluctuations, population mobility changed, and personal hygiene practices such as HWWS increased at the beginning of the pandemic but are thought to have declined during the recovery period. In addition, population distribution patterns in Depok have changed in line with new residential growth, migration, and shifts in socioeconomic activities. All these dynamics are likely to influence TB trends and distribution patterns from year to year.

The policy implications of this study emphasize the importance of area-based TB control, prioritizing densely populated subdistricts as the main areas of intervention. Recommended strategies include community-based active TB screening, strengthening health center surveillance in priority areas, improving ventilation in densely populated dwellings, and integrating the promotion of clean and healthy living behaviors as a supporting strategy. The use of GIS needs to be institutionalized in regional TB programs to monitor risk dynamics and evaluate the effectiveness of interventions on an ongoing basis.

5. Acknowledgments

We would like to thank the Central Statistics Agency (BPS) and the Depok City Health Office for providing open data for further observation and analysis. We would also like to thank those who have helped in the writing of this article so that it could be completed.

6. References

- Al Muchtary, A., & Fatarona, A. (2023). Analisis Faktor yang Mempengaruhi Perilaku Pencegahan Penularan Tuberkulosis Pada Penderita Tuberkulosis di Puskesmas Sumber Sari (Doctoral Dissertation, Universitas Dr. Soebandi). From <http://repo.uds.ac.id/id/eprint/1138/>
- Alhawaris, A., & Tabri, N. A. (2020). Risiko Infeksi Mycobacterium Tuberculosis Pada Orang Yang Tinggal Serumah Dengan Penderita Tuberkulosis Di Makassar. Jurnal Kedokteran Mulawarman. From <https://ocs.unmul.ac.id/index.php/JKM/article/view/3892>
- Damayanti, L. G. T., Sukmawati, N. W. L., Sari, N. P. A. P., Suciptawati, N. L. P., & Dwipayana, I. M. E. (2024). Analisis Pola Sebaran Kasus TBC di Jawa Barat Dengan Pendekatan VTMR dan Autokorelasi Spasial. Journal on Education.
- Danuartha, I. B. G. K., Adriyani, R., & Fitriandini, L. L. (2025). TPengaruh luas ventilasi, kepadatan hunian dan kualitas udara dalam ruangan terhadap kejadian TB paru di Surabaya. Jurnal Kesehatan Tambusai. From <https://doi.org/10.31004/jkt.v6i2.45797>
- Deol, A. K., Shaikh, N., Middelkoop, K., Mohlamonyane, M., White, R. G., & McCreesh, N. (2022). Importance of ventilation and occupancy to Mycobacterium tuberculosis transmission rates in congregate settings. BMC public health, 22(1), 1772.
- Fadhillah, M. I. Studi Korelasi Dan Pemetaan Spasial Kasus Tuberkulosis Di Kota Bogor Tahun 2023. From <https://dinkes.kotabogor.go.id/storage/documents/47db9189-4e67-4f83-ae9e-e89c88af7b2e.pdf>
- Faizal, I. A., & Pangesti, I. (2021). House Environments As Risk Factors of Tuberculosis in Cilacap District. Jurnal Riset Kesehatan, 10(1), 65-70.
- Gultom, A. M., Nurmaini, N., & Siregar, F. A. (2022). The effect of physical conditions of home and work environment on the event of pulmonary tuberculosis in construction workers. Jurnal Riset Kesehatan, 11(1), 40-47.
- Imalia, A. (2024). Analisis Hubungan Lingkungan Fisik Rumah Terhadap Kejadian COVID-19 di Lingkungan Perumahan Kelurahan Sragen Kulon. Media Gizi Kesmas, Vol. 13, No. 1, June 2024: 206-213. From <https://e-journal.unair.ac.id/MGK/article/download/48367/29270>
- Issarow, C. M., Mulder, N., & Wood, R. (2018). Environmental and social factors impacting on epidemic and endemic tuberculosis: a modelling analysis. Royal Society open science, 5(1).
- Kementerian Kesehatan Republik Indonesia. (2019). Apa itu TOSS TBC dan kenali gejala TBC Ayo Sehat. From <https://ayosehat.kemkes.go.id/apa-itu-toss-tbc-dan-kenali-gejala-tbc>
- Kementerian Kesehatan Republik Indonesia. (2025). Buku panduan tenaga medis dan tenaga kesehatan: Tuberkulosis. Kementerian Kesehatan RI From <https://www.tbindonesia.or.id/wp-content/uploads/2025/01/Buku-Panduan-Tenaga-Medis-dan-Kesehatan-Tuberkulosis.pdf>
- Martias, I., & Sitanggang, H. D. (2018). Karakteristik Fisik Rumah Dengan Kejadian Tb Paru Di Wilayah Kerja Puskesmas Sei Jang Kota Tanjungpinang. Jurnal Riset Kesehatan, 7(1), 17-20.
- Marzuki, D. S., & Tahrir, N. (2024). Derajat kesehatan masyarakat. Uwais Inspirasi Indonesia. [Book].

- From
https://books.google.com/books?hl=id&lr=&id=cpnuEAAAQBAJ&oi=fnd&pg=PR7&dq=CTPS+can+reflect+the+level+of+public+health+awareness+that+affects+vulnerability+to+disease&ots=E10OrRPCDH&sig=OdTXbn_Iwd36pCiru4DUgCmaLVY
- Mohidem, N. A., Hashim, Z., Osman, M., Muharam, F. M., Elias, S. M., & Shaharudin, R. (2021). Environment as the risk factor for tuberculosis in Malaysia: a systematic review of the literature. *Reviews on Environmental Health*, 36(4), 493-499.
- Nurhayati, E., Rahmawati, E., Sutriswanto, S., Tumpuk, S., & Triana, L. (2025). Kontak serumah dan kejadian penularan tuberculosis di Pontianak Barat. *Jurnal Laboratorium Khatulistiwa*, From <https://doi.org/10.30602/jlk.v8i2.1859>
- Nurrizki, F. L. (2021). Hubungan Kualitas Lingkungan Fisik Rumah Dengan Kejadian Tuberkulosis Paru Di Wilayah Kerja Puskesmas Rawat Inap Simpur Kota Bandar Lampung Tahun 2021 (Doctoral dissertation, Poltekkes Tanjungkarang). From <https://repository.poltekkes-tjk.ac.id/id/eprint/891/>
- Pemerintah Provinsi Jawa Barat. (2022). Profil Kesehatan Kota Depok. Jawa Barat: Pemerintah Provinsi Jawa Barat
- Pemerintah Provinsi Jawa Barat. (2023). Profil Kesehatan Kota Depok. Jawa Barat: Pemerintah Provinsi Jawa Barat
- Pemerintah Provinsi Jawa Barat. (2024). Profil Kesehatan Kota Depok. Jawa Barat: Pemerintah Provinsi Jawa Barat
- Pemerintah Provinsi Jawa Barat. (2024). Temuan kasus tuberculosis Jawa Barat selalu 100 persen dalam dua tahun terakhir. From <https://www.jabarprov.go.id/berita/temuan-kasus-tuberkulosis-jabar-selalu-100-persen-dalam-dua-tahun-terakhir-12478>
- Ramadhani, L. F., Setiawan, S., Suryono, H., Marlik, M., & Rusmiati, R. (2022). Determinasi perilaku sebagai faktor risiko terjadinya tuberculosis paru di wilayah Puskesmas Mojo Surabaya (Studi pendekatan teori Health Belief Model). *JPP (Jurnal Kesehatan Poltekkes Palembang)*. From <https://doi.org/10.36086/jpp.v17i2.1344>
- Siregar, F. A., & Hasan, W. (2019). Determinan Sosial dan Lingkungan Terhadap Kejadian TB Paru Kontak Serumah yang Berobat di Rumah Sakit Khusus Paru Medan Tahun 2018 (Doctoral dissertation, Universitas Sumatera Utara). From <https://repositori.usu.ac.id/handle/123456789/25592>
- Siregar, S. J., Fahlevi, M. I., Lutfi, F., Sriwahyuni, S., Yulizar, Y., & Rafsanjani, T. (2025). aktor-faktor risiko yang berhubungan dengan kejadian tuberculosis pada kontak TBC positif berdasarkan data investigasi kontak di kota Mataram. *PREPOTIF : Jurnal Kesehatan Masyarakat*. From <https://doi.org/10.31004/prepotif.v9i2.48071>
- TechnoGIS. (2024). Manfaat sistem informasi geografis (SIG) dalam bidang kesehatan masyarakat: Pemetaan penyebaran penyakit dan fasilitas kesehatan. From <https://www.technogis.co.id/manfaat-sig-dalam-bidang-kesehatan-masyarakat-pemetaan-penyebaran-penyakit-dan-fasilitas-kesehatan/>
- Wedhaswari, I. A. M. I. (2025). nalisis faktor kualitas fisik rumah terhadap kejadian tuberculosis paru di wilayah kerja UPTD Puskesmas II Denpasar (Undergraduate thesis). Poltekkes Kemenkes Denpasar Repository.
- World Health Organization. (2024). Global tuberculosis report 2024: TB disease burden. World Health Organization. From <https://www.who.int/teams/global-programme-on-tuberculosis-and-lung-health/tb-reports/global-tuberculosis-report-2024/tb-disease-burden/1-1-tb-incidence>
- World Health Organization. (2025). Tuberculosis. World Health Organization. From <https://www.who.int/news-room/fact-sheets/detail/tuberculosis> (Definition)
- World Health Organization. (2025). Tuberculosis. World Health Organization. From <https://www.who.int/news-room/fact-sheets/detail/tuberculosis> (Definition)
- World Health Organization. (2025). Tuberculosis: Overview. World Health Organization. From <https://www.who.int/health-topics/tuberculosis>