
Spatial and Descriptive Epidemiology of Tuberculosis Cases in the Ngaliyan Primary Health Care in 2022-2024

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Abstract. In Ngaliyan Primary health care Semarang City there were 378 cases of tuberculosis during 2022–2024, with the highest number recorded in 2023. The uneven distribution of cases between areas indicates the need for spatial analysis. Objective: To analyze the spatial distribution and epidemiological characteristics of tuberculosis cases based on person, place, and time. Method: Descriptive epidemiological study with a spatial epidemiology using secondary data from 378 tuberculosis cases. Mapping was conducted using QGIS based on villages and RW and Descriptive analysis. Results: tuberculosis cases were more common among adults and males overall. Spatial concentrations were observed in Bringin Village (103 cases) and Wates Village (65 cases), with RW 1 in Wates showing the highest concentration in 2022–2024. Conclusion: TB cases showed an uneven spatial distribution, with concentrations in several villages and RW.

Keywords: Tuberculosis, Age, Gender, Month of Treatment, Region

INTRODUCTION

Tuberculosis infection occurs due to exposure to *Mycobacterium tuberculosis* bacteria that can survive in the air and be inhaled by healthy individuals, especially when people with tuberculosis do activities such as coughing. Based on the Global Tuberculosis Report 2024, TB is still a global public health problem with millions of new cases every year, especially in low- and middle-income countries, including in the Southeast Asian region which accounts for most of the world's TB case burden ¹. Indonesia is listed as one of the high burden countries with a high estimated TB case and significant challenges in the detection and control of this disease. Nationally, until the latest year reportedly, the recording of TB cases in Indonesia continues to increase along with the improvement of the detection and reporting system, with hundreds of thousands of cases identified every year and there is still a gap in undetected cases. A systematic approach to early detection, discovery of active cases, and therapeutic monitoring is an essential component of the TB elimination strategy adopted by the Ministry of Health of the Republic of Indonesia ².

At the provincial level, the achievement of TB control in Central Java shows quite positive developments. By 2024, the coverage of TB case discovery in this province has exceeded the national target of 90%, with an achievement of 90.5% or as many as 87,706 cases that have been found out of the target of 96,917 cases. However, the distribution of TB cases between districts/cities is still uneven. The city of Semarang was recorded as contributing 9,989 TB cases or around 11.4% of the total TB cases in Central Java, which confirms that this urban area still has a considerable TB burden and needs to strengthen sustainable control efforts ³.

TB control efforts at the primary level, including in the work area of the health center, face various challenges such as delayed diagnosis, discontinuation of treatment, low adherence to therapy, and socio-economic factors that affect the success of treatment. Although a number of strategies have been implemented, such as Directly Observed Treatment Short-course (DOTS), strengthening surveillance, and public education campaigns, the level of case discovery and handling according to protocol standards still needs to be improved to meet the TB elimination target mandated by WHO and the national government ⁴.

In the context of modern public health, the spatial epidemiology approach is an important tool for understanding disease distribution patterns. Spatial analysis using Geographic Information Systems (GIS) allows for the identification of case spatial, mapping of high-risk areas, and evaluation of the relationship between environmental and epidemiological determinants and TB incidence. Spatial mapping of TB cases has been used in a number of studies as the basis for recommendations for more targeted interventions at the local and regional levels ⁵.

Ngaliyan District is one of the areas in Semarang City with a relatively high burden of Tuberculosis (TB) cases. Based on data from the Ngaliyan Health Center TB program, 111 cases were recorded in 2022, increasing to 158 cases in 2023, and decreasing to 109 cases in 2024. Despite a decline in 2024, the number of cases still shows that TB remains a significant public health problem, considering its high potential for transmission, long treatment period, and the impact of TB on people's productivity and quality of life. This condition emphasizes the need for sustainable, directed, and data-based control efforts to effectively reduce the incidence of TB in Ngaliyan District.

Until now, research that comprehensively maps the spatial distribution of Tuberculosis (TB) cases at the level of the health center's work area, especially in recent years, is still limited. This condition can hinder evidence-based decision-making in TB control at the local level. Therefore, this study aims to map the spatial distribution and analyze the pattern of pulmonary TB incidence in the work area of the Ngaliyan Health Center, Semarang City, during the 2022–2024 period, as the basis for the preparation of recommendations for more effective intervention strategies at the community and health service levels.

Mapping of Tuberculosis (TB) cases is necessary because the distribution of cases in Ngaliyan District is uneven between regions, which is influenced by differences in environmental conditions, socio-economic, and access to health services. Without clear mapping, TB control efforts tend to be general and less targeted. Therefore, this study aims to conduct spatial mapping of TB cases while analyzing epidemiological characteristics based on aspects of people, places, and times. This analysis is expected to be able to identify areas with a high number of cases, understand the distribution patterns and trends of TB transmission, and describe the characteristics of TB patients in Ngaliyan District. The results of this study are expected to be used as a basis for determining priorities for handling, planning, implementing, and evaluating TB control programs to be more effective, on target, and sustainable. This study aims to analyze the spatial distribution and epidemiological characteristics of Tuberculosis cases based on people, places, and times in the work area of the Ngaliyan Health Center in 2022–2024.

METHODS

This study is descriptive epidemiological study using secondary surveillance data. Secondary data on Pulmonary Tuberculosis cases in 2022–2024 was obtained from the Ngaliyan Health Center. Spatial analysis was carried out using QGIS software to map the distribution of cases by sub-district and RW. Data analysis was conducted descriptively demographic, time, and region variables with the number of TB cases.

RESULT

Distribution of TB Cases Based on Patient Characteristics

Table 1. Number of TB Cases by Age Group in the Ngaliyan Health Center Working Area in 2022-2024

Age Group	Year					
	2022		2023		2024	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Babies & Toddlers	32	28,8	58	36,7	22	20,1
Children	6	5,4	13	8,2	8	7,3
Teenagers	3	2,7%	9	5,6	9	8,2
Adult	56	50,4%	61	38,6	59	54,1
Elderly	14	12,6%	17	10,7	11	10
Total	111	100	158	100	109	100

Based on the table above, the distribution of Tuberculosis (TB) cases by age group shows variations in the number and proportion of cases across the observation years. In 2022, the adult group had the largest number of cases 50,4%. In 2023, adults again had the largest number of cases 38,6%. In 2024, adults remained the group with the largest number of cases 54,1%.

Table 2. Number of TB Cases by Gender at the Ngaliyan Health Center in 2022-2024

Gender	Year					
	2022		2023		2024	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Male	69	62,1	95	60,1	64	58,7
Women	42	37,9	63	39,9	45	41,3
Total	111	100	158	100	109	100

The distribution of Tuberculosis (TB) cases by sex shows that males consistently had a higher number of recorded cases than females across the three observation years.

Distribution by Year of Tuberculosis (TB) Cases

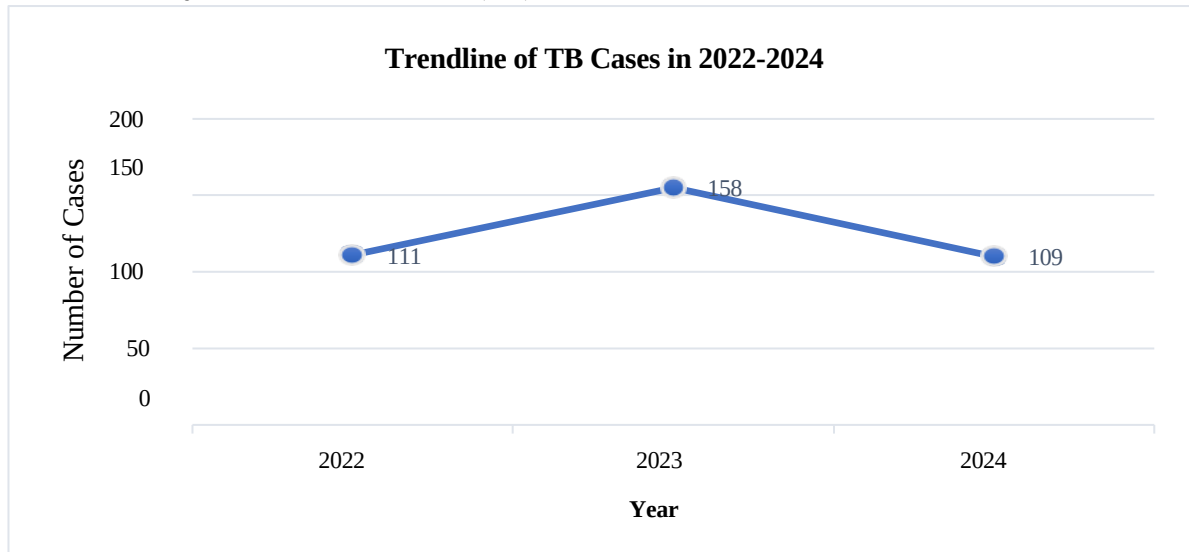


Figure 1. Trendline of All TB Cases in 2022-2024 at the Ngaliyan Health Center

During the 2022–2024 period, 378 cases of Tuberculosis were recorded in the working area of the Ngaliyan Health Center, with the highest number occurring in 2023. In 2022, there were 111 TB cases, increasing to 158 cases in 2023, then decreasing to 109 cases in 2024.

Distribution by Month of Occurrence of Tuberculosis (TB) Cases

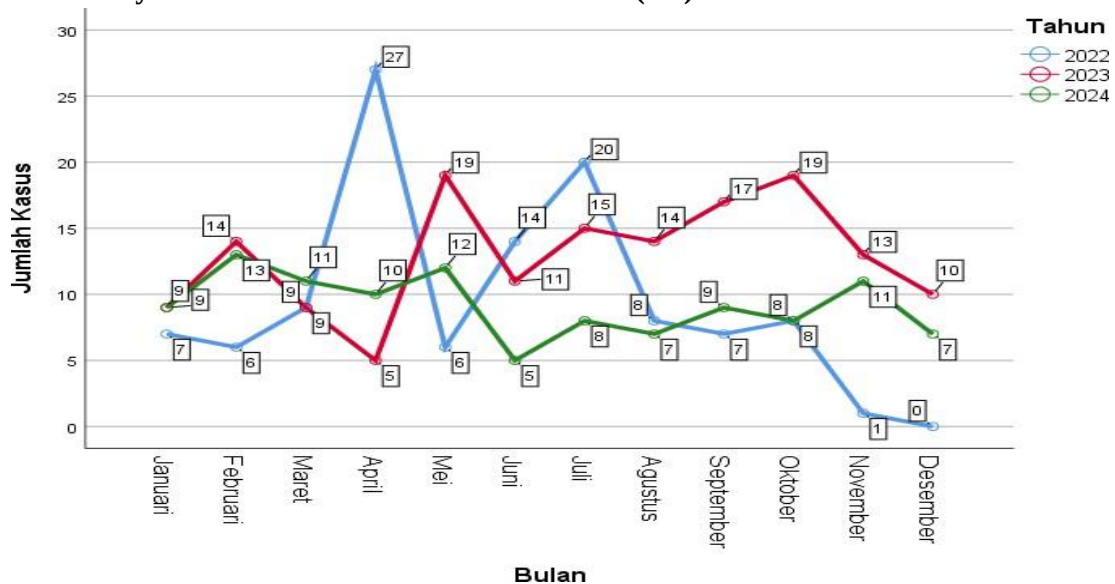


Figure 2. Trendline of TB Cases Per Month from 2022-2024 Ngaliyan Health Center

Based on the results of the analysis of cross-tabulation between the categories of months and the year of the incident, it is known that during the 2022–2024 period, there were 378 cases of Tuberculosis (TB) in the working area of the Ngaliyan Health Center. The distribution of TB cases by month shows different variations from year to year. In 2022, the highest number of TB cases occurred in April with 27 cases, followed by July with 20 cases and June with 14 cases. Meanwhile, no TB cases were found

in November and December. This pattern indicates an increase in cases in the middle of the year, which may be related to environmental factors or increased community activities.

In 2023, the distribution of TB cases showed a relatively more even pattern throughout the year. The highest TB cases were recorded in October with 19 cases, followed by May with 19 cases and September with 17 cases. The absence of a case-free month this year indicates that TB transmission and detection occur throughout the year without a case-free period. Meanwhile, in 2024, the highest number of TB cases occurred in February with 13 cases, followed by May with 12 cases and March and November with 11 cases each. The lowest TB cases in 2024 were recorded in June as many as 5 cases, which shows a decrease in cases at the beginning of the dry season.

Distribution of Tuberculosis Cases by Village Per Year

Table 3. TB Cases Based on Per Village in the Ngaliyan Health Center Working Area for 2022-2024

Village	Year					
	2022		2023		2024	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Ngaliyan	30	27	31	19,6	24	22,0
Bringin	22	19,8	55	34,8	26	23,8
Bambankerep	11	9	19	12,1	17	15,7
Wates	34	30,6	17	10,8	14	12,8
Podorejo	7	6,3	16	10,1	13	11,9
Gondoriyo	7	6,3	20	12,6	15	13,8
Total	111	100	158	41,8%	109	28,8%

Based on the table above, in 2022 the most incidents were found in Wates Village with a percentage of 30,6%, then in 2023 there was an increase in incidents with the highest percentage found in Bringin Village at 34,8%, while in 2024 the number of incidents will decrease and the percentage distribution will be more even between villages with the highest percentage being found in Bringin Village at 23,8%.

Distribution of Tuberculosis Cases by RW and Urban Areas

Based on the results of the recapitulation of Tuberculosis (TB) cases according to the Rukun Warga (RW) and sub-districts during the 2022-2024 period in the work area of the Ngaliyan Health Center, it can be seen that there is an uneven distribution of cases between regions, both between sub-districts and between RWs in the same sub-district.

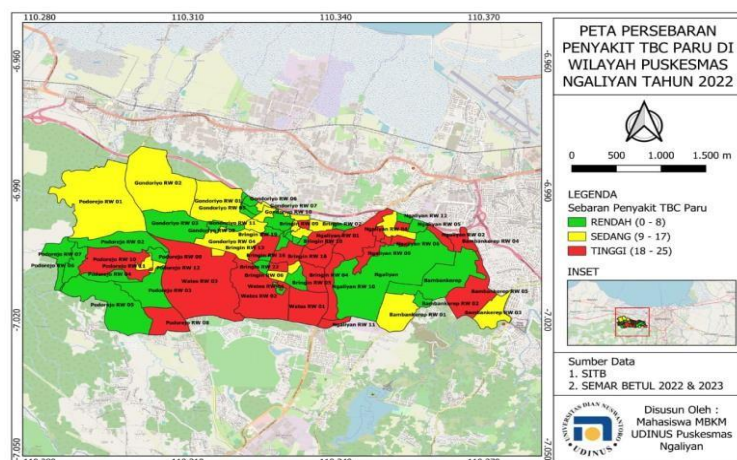


Figure 3. Distribution Map of TB Cases by RW in 2022

In 2022, the mapping showed a very prominent concentration of cases in Wates Village, especially RW 1 with a total of 25 cases, which was the highest contribution compared to other RWs that year. In addition, a relatively higher number of cases were also found in Ngaliyan Village, especially in RW 2 (8 cases) and RW 1 and RW 4 (5 cases each). Meanwhile, in other villages such as Bambankerep, Bringin, Gondoriyo, and Podorejo, most RWs only recorded 1-3 cases, showing a relatively lower and scattered case load.

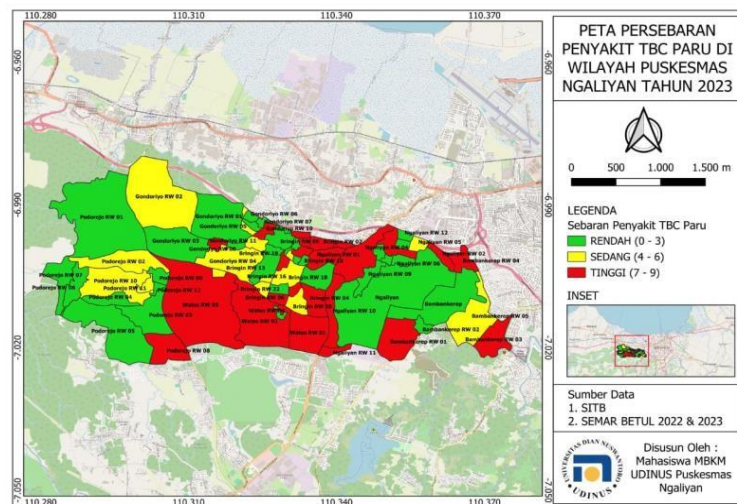


Figure 4. Map of the Distribution of TB Cases by RW in 2023

In 2023, the results of QGIS visualization indicate an expansion of the affected area, where Bringin Village is the area with the highest number of affected RWs, with the highest cases recorded in RW 1 (8 cases) and RW 3 (9 cases). In Wates Village, TB cases are relatively high in RW 1 (7 cases) and RW 2 (5 cases). Meanwhile, Ngaliyan Village shows a fairly even distribution of cases in several RWs, with the number of cases ranging from 1-8 cases per RW. These findings indicate an expansion of areas with TB incidence compared to the previous year.

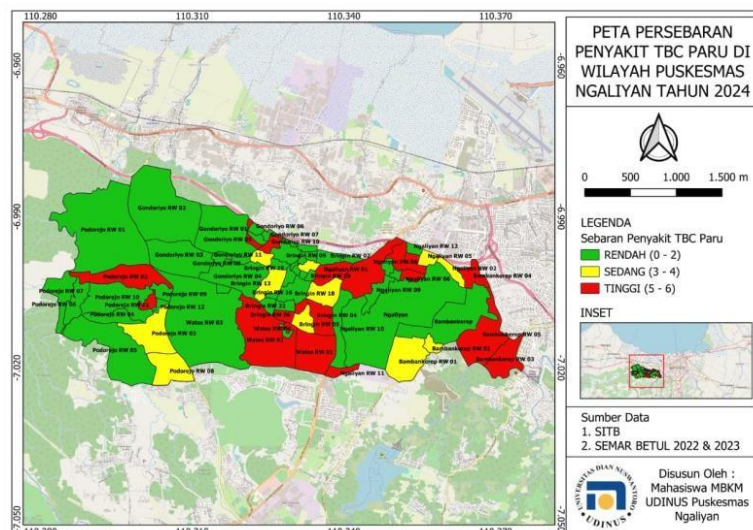


Figure 5. Distribution Map of TB Cases by RW in 2024

In 2024, the results of spatial mapping prove that TB is still concentrated in certain locations that are consistent every year, Wates Village again shows a relatively high number of cases, especially in RW 1 and RW 2 (6 cases each). In addition, Bambankerep Village and Bringin Village also show a concentration of cases in certain RWs, such as RW 3 and RW 4. In Ngaliyan Village, TB cases are spread across several RWs with a relatively smaller number of cases, but they consistently appear every year. It can be concluded from the analysis per year, that RW 1 Wates Village consistently shows a higher proportion of TB cases reaching an average of 13 cases each year compared to other RWs in the 2022-2024 period, so that it can be categorized as an area with a high incidence of TB on an ongoing basis.

DISCUSSION

The results of the study show that the incidence of TB in the work area of the Ngaliyan Health Center is fluctuating during the 2022–2024 period, it is known that the total number of tuberculosis (TB) cases recorded during the 2022–2024 period amounted to 378 cases. The increase in TB cases in 2023 can reflect several possibilities, including increased case finding activities after the COVID-19 pandemic, improvements in the reporting system, and the recovery of public access to health services. Similar phenomena have also been reported in various studies that state that after the pandemic, there is an accumulation of TB cases that were previously not detected optimally ⁶. Meanwhile, a decrease in the proportion of cases in 2024 can indicate the effectiveness of TB control programs, such as increasing treatment success, intensifying screening of at-risk groups, and strengthening the role of primary health care facilities, including health centers. However, this decline also needs to be interpreted with caution as it can be influenced by reporting factors, delayed diagnosis, or data that has not been fully accumulated in a current year ⁷.

The results of the study show that the adult age group is consistently the group with the highest number of Tuberculosis (TB) cases during the 2022–2024 period in the working area of the Ngaliyan Health Center. The dominance of TB cases in adulthood reflects the high risk of exposure in the productive age group who have high mobility, greater intensity of social interaction, and active involvement in economic and social activities. This condition increases the chance of TB transmission through droplets in work environments, public transportation, and dense settlements. These findings are in line with a World Health Organization report (2022) which states that the productive age group is the largest contributor to TB cases globally ⁸.

In addition, the relatively high number of TB cases in infants and toddlers, especially in 2022 and 2023, indicates the possibility of household transmission. Early childhood is particularly vulnerable to TB infection due to an underdeveloped immune system and high dependence on adults as the main source of exposure. Previous research has shown that the presence of adult TB patients in the home increases the risk of TB in children by several times, especially in environments with inadequate ventilation ⁷. TB cases in the elderly group that are relatively stable every year also need special attention. Aging of the immune system (immunosenescence), the presence of comorbidities, and delayed diagnosis often cause TB in the elderly to be detected at an advanced stage. This is in accordance with the findings of a study that states that the elderly have a higher risk of experiencing reactivated latent TB than other age groups ⁹. Meanwhile, the distribution of TB cases by sex showed that males consistently had a higher number of cases than females across the observation years. These differences can be explained by biological, behavioral, and social factors. Behaviorally, men are more often exposed to TB risk factors, such as smoking, alcohol consumption, and working in environments with dust exposure and poor ventilation. In addition, men tend to have a slower pattern of seeking treatment than women, thus increasing the risk of transmission and delayed diagnosis ⁸. Biologically,

several studies have shown a difference in immune response to *Mycobacterium tuberculosis* between men and women, where sex hormones are thought to play a role in modulating the immune system against TB infection (Nhamoyebonde & Leslie, 2019). These findings reinforce the results of the study that men are a more vulnerable group and need to be the main target in TB early detection and prevention efforts ¹⁰.

Cumulatively during the three years of observation (378 cases), April (45 cases; 11.8%) and July (43 cases; 11.3%) were the months with the highest number of TB cases, while December was the month with the lowest cases (16 cases; 4.2%). The monthly variation in TB cases reflects differences in detection and reporting rather than consistent seasonal patterns. Monthly fluctuations can be related to the intensity of active case finding activities and the implementation of TB programs in primary health care facilities. An increase in cases in a given month does not necessarily reflect an increase in transmission, but may also indicate an increase in case detection due to more intensive screening activities ⁸.

The consistency of TB clusters in Wates and Bringin Villages shows that environmental factors and settlement density play an important role in TB transmission, as reported in GIS-based studies in other urban areas. Spatial analysis of pulmonary tuberculosis (TB) cases in the working area of the Ngaliyan Health Center for the 2022–2024 period shows that the distribution of cases does not occur randomly, but rather forms a spatial clustering pattern with a relatively consistent concentration of cases in certain villages, especially Wates Village and Bringin Village. This pattern is in line with the findings of research based on Geographic Information Systems (GIS) in various regions which states that TB tends to be concentrated in areas with certain environmental and social characteristics ¹¹. The results of the analysis showed that TB cases were spread across six villages with uneven distribution. Bringin Village recorded the highest proportion of cases, namely 103 cases (27.2%), followed by Ngaliyan Village with 85 cases (22.5%), Wates with 65 cases (17.2%), Bambankerep with 47 cases (12.4%), Gondoriyo with 42 cases (11.1%), and Podorejo with the lowest number of cases, namely 36 cases (9.5%).

The high concentration of TB cases in Wates Village can be explained by the existence of the Kedungpane Class I Correctional Institution, which is epidemiologically known as a high-risk environment for TB transmission. Global research shows that the prevalence of TB in correctional settings can be many times higher than that of the general population due to overcrowding conditions, poor ventilation, limited natural lighting, and high intensity of contact between individuals ¹. The study by Walter et al. (2025) also confirms that prisons not only play a role as an internal transmission location, but can also be a source of transmission to the surrounding community, especially through the mobility of officers, family visits, and the process of reintegrating the inmates into their living environment. This strengthens the finding that the TB cluster in Wates Village cannot be separated from the influence of the institutional environment ¹².

Meanwhile, the high incidence of TB in Bringin Village is closely related to the characteristics of the area as a densely populated residential area. Research in Indonesia shows that housing density has a significant relationship with an increased risk of TB, especially when home conditions are not supported by adequate ventilation and good environmental sanitation ¹³. In the context of TB epidemiology, the narrow distance between homes and high social interaction in congested areas facilitate the transmission of *Mycobacterium tuberculosis* through droplets when people cough or talk in enclosed spaces ^{14, 15}. Access to health care may include distance and travel time to health facilities, the availability and condition of transportation, and surrounding environmental conditions ¹⁶. However, these factors were not directly analyzed in the present study; therefore, they cannot be concluded to be the causes of the association between village of residence and the number of TB cases.

The number of TB cases among males was higher than among females in each year of observation. This difference may be related to several characteristics that were not directly analyzed in this study, such as smoking behavior, social activities, and environmental exposure. The high proportion of smokers reported in the study area may provide additional context for understanding the difference in TB cases by sex. However, because smoking behavior was not analyzed as a variable in this study, it cannot be concluded to be the cause of the observed association. This finding is consistent with the study by Rahmawati et al., which reported a significant association between sex and the incidence of tuberculosis^{17,18}. These findings suggest that there is no clear seasonal pattern of TB incidence during the observation period, so fluctuations in the number of cases between months do not correlate with the time of occurrence.

CONCLUSION

Tuberculosis cases within the service area of the Ngaliyan Community Health Center between 2022 and 2024 exhibited a fluctuating pattern, with the highest number of cases recorded in 2023. Cases were concentrated among the adult population and were more prevalent in males throughout the three-year study period. Spatial analysis revealed an uneven distribution, with concentrations in specific urban villages particularly Bringin and Wates and a persistent cluster in RW 1 of Wates Village.

LIMITATION

This study has several limitations. First, the analysis was based on recorded tuberculosis cases and did not include population denominators; therefore, the findings describe case counts rather than incidence rates or differences in population-level risk. Second, the descriptive design did not assess associations between tuberculosis cases and potential risk factors, such as household conditions, population density, smoking, or exposure in correctional facilities. Third, the observed distribution may have been influenced by case detection, reporting practices, and the completeness of secondary data. Finally, the geographic maps illustrate the distribution of recorded cases and should not be interpreted as evidence of statistically significant spatial clustering.

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