

RESEARCH ARTICLE

Population Density, Number of TB Cadres and Number of Healthcare Facilities with Tuberculosis Cases in Shoutheast Maluku Regency

Kepadatan Penduduk, Jumlah Kader dan Jumlah Fasyankes dengan Kasus Tuberkulosis di Kabupaten Maluku Tenggara

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Abstract

Tuberculosis (TBC) still holds a major role as a health problem in Indonesia, especially in Southeast Maluku Regency. This study aimed to determine the relationship between population density, the number of TBC cadres, and the number of healthcare facilities and TB incidence in Southeast Maluku Regency in 2024-2025. This study employed a quantitative research design with a cross-sectional approach. Secondary data were used from 11 sub-districts in Southeast Maluku Regency in 2024-2025 with a total sample of 22 observations. Data analysis was performed using univariate and bivariate methods using the Spearman Correlation Test. The results showed that there was a significant relationship between TBC incidence with a p-value of 0.029 and a correlation coefficient (r) of 0.466. In addition, there was a significant relationship between the number of TBC cadres and TBC incidence, with a p-value of 0.001 and a correlation coefficient (r) of 0.787. The same results were also obtained in the relationship between the number of health service facilities and TBC incidence, with a p-value of 0.001 and a correlation coefficient (r) of 0.787. The conclusion of this study is that there's a relationship between population density, the number of TBC cadres, and the number of health care facilities with TBC incidence in Southeast Maluku Regency in 2024-2025. The Department of Health and Healthcare facilities in Southeast Maluku Regency could improve by strengthening surveillance, detecting active cases, and increasing the role of health cadres in the community.

Keywords: healthcare facilities, population density, TBC cadres, tuberculosis

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Abstrak

Tuberkulosis (TBC) merupakan salah satu penyakit menular yang masih menjadi masalah kesehatan di Indonesia, termasuk di Kabupaten Maluku Tenggara. Faktor kepadatan penduduk, jumlah kader TBC, dan fasilitas pelayanan kesehatan diduga memiliki hubungan terhadap jumlah kasus TBC tercatat. Penelitian ini bertujuan untuk mengetahui hubungan kepadatan penduduk, jumlah kader TBC, dan jumlah fasilitas pelayanan kesehatan dengan jumlah kasus TBC tercatat di Kabupaten Maluku Tenggara tahun 2024–2025. Penelitian ini menggunakan desain penelitian kuantitatif dengan pendekatan cross-sectional. Data yang digunakan merupakan data sekunder dari 11 kecamatan di Kabupaten Maluku Tenggara tahun 2024–2025 dengan total sampel sebanyak 22 data observasi. Analisis data diolah secara univariat dan bivariat menggunakan uji korelasi Spearman. Hasil penelitian menunjukkan bahwa terdapat hubungan yang signifikan antara kepadatan penduduk dengan jumlah kasus TBC tercatat dengan nilai p -value sebesar 0,029 dan koefisien korelasi (r) sebesar 0,466, serta terdapat hubungan yang signifikan antara jumlah kader TBC dengan jumlah kasus TBC tercatat dengan nilai p -value sebesar 0,001 dan koefisien korelasi (r) sebesar 0,787. Hasil yang sama juga diperoleh pada hubungan jumlah fasilitas pelayanan kesehatan dengan jumlah kasus TBC tercatat dengan nilai p -value sebesar 0,001 dan koefisien korelasi (r) sebesar 0,787. Kesimpulan penelitian ini adalah terdapat hubungan antara kepadatan penduduk, jumlah kader TBC, dan jumlah fasilitas pelayanan kesehatan dengan jumlah kasus TBC tercatat di Kabupaten Maluku Tenggara tahun 2024–2025. Dinas Kesehatan dan fasilitas pelayanan kesehatan dapat meningkatkan upaya pengendalian TBC melalui penguatan surveilans, penemuan kasus aktif, serta peningkatan peran kader kesehatan dalam masyarakat.

Kata Kunci: fasilitas pelayanan kesehatan, kader TBC, kepadatan penduduk, tuberkulosis

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Highlight:

- Higher population density correlates with an increased incidence of tuberculosis due to elevated contact intensity and heightened inter-individual transmission risk
- The density of community health cadres positively correlates with the efficiency of contact tracing and case notification of tuberculosis
- Greater availability of healthcare facilities enhances early detection access and epidemiological surveillance reporting, thereby optimizing case detection coverage in the population

INTRODUCTION

Tuberculosis remains a major public health challenge globally, including in Indonesia. Caused by *Mycobacterium tuberculosis*, this airborne disease continues to exhibit a high incidence rate, particularly in developing countries. The high burden of tuberculosis is driven by various determinants, such as population density, healthcare service conditions, and community engagement in disease control programs (Suryani and Ibad, 2022).

Indonesia is among the countries with the highest tuberculosis burden worldwide. High population density significantly elevates the risk of tuberculosis transmission due to frequent inter-individual contact and overcrowded living conditions. Furthermore, the

availability of healthcare facilities plays a pivotal role in case detection, treatment provision, and disease control within the community. Regions with restricted access to healthcare facilities face a higher vulnerability to delayed diagnosis and management of tuberculosis cases (Fitri, 2024).

In addition to healthcare infrastructure, tuberculosis cadres play a crucial role in disease control initiatives. These cadres are actively involved in health promotion, active case finding, treatment adherence counseling, and community education regarding prevention and control measures. An adequate supply of tuberculosis cadres is expected to bolster the overall success of community-based control programs (Andrianovita and Gustina, 2022).

Southeast Maluku Regency still faces challenges in controlling tuberculosis cases. Variations in population density, the number of healthcare facilities, and the number of TB cadres across sub-districts are presumed to influence the variation in tuberculosis cases during 2024–2025. However, research investigating the relationship between these three factors and tuberculosis cases in Southeast Maluku Regency remains limited. Therefore, this study was conducted to analyze the relationship of population density, the number of healthcare facilities, and the number of TB cadres with tuberculosis cases in Southeast Maluku Regency from 2024–2025.

METHODS

This observational quantitative study employed a cross-sectional design using secondary data. This study aimed to analyze the relationship of population density, the number of healthcare facilities, and the number of tuberculosis cadres with tuberculosis cases in Southeast Maluku Regency from 2024 to 2025. Conducted in May 2026, the research utilized secondary data obtained from the Southeast Maluku Regency Health Office. The unit of analysis was sub-district per year, yielding 22 observation units across 11 sub-districts in Southeast Maluku Regency observed over two annual periods (2024 and 2025). Sampling was conducted via total sampling, incorporating all sub-districts within Southeast Maluku Regency as research observations. Tuberculosis case data were retrieved from the Southeast Maluku Regency Health Office based on the 2024–2025 tuberculosis registration and reporting records. Cases evaluated in this study comprised all recorded and reported tuberculosis cases within each respective sub-district. Because identical sub-districts were repeatedly observed across the two-year period, analytical results are interpreted as spatial-level associations rather than individual-level associations. This condition represents a study limitation, given that inter-period observations originated from identical sub-district territories.

Population density data were measured based on the number of residents per square kilometer (people/km²) in each sub-district for 2024–2025. The number of healthcare facilities was measured based on the total Primary Healthcare Facilities (*Fasilitas Kesehatan Tingkat Pertama/FKTP*) recorded in each sub-district, comprising public health centers (*puskesmas*) and clinics. The number of TB cadres was measured based on the recorded count of tuberculosis cadres in each sub-district during 2024–2025. Tuberculosis cases were measured as the total recorded and reported TB cases across each sub-district throughout 2024–2025. FKTP represents primary-level healthcare services operating within the sub-district scope. This study utilized absolute counts of TB cases rather than case rates per 100,000 population or TB notification rates. Consequently, variations in case counts across sub-districts must be carefully considered as they may be influenced by population size differences, representing a

study limitation.

Data processing and statistical analyses were performed using Microsoft Excel and IBM SPSS Statistics. Univariate and bivariate analyses were conducted. Univariate analysis described the distribution of each study variable, while bivariate analysis evaluated the relationships between population density, healthcare facilities, and TB cadres with tuberculosis cases. Statistical hypothesis testing utilized Spearman rank correlation with a 95% confidence interval ($\alpha = 0.05$). Spearman correlation was chosen because the dataset violated parametric assumptions and non-normal distribution. Data are presented through tables and narrative descriptions to facilitate interpretation.

Data were retrieved from the Southeast Maluku Regency Health Office following formal administrative authorization from relevant authorities. The dataset comprised aggregated sub-district level data devoid of personal identifiable information; thus, no primary individual data collection was required. The authors declare no conflict of interest regarding the execution and publication of this study.

RESULTS AND DISCUSSION

Table 1 presents a univariate analysis conducted to describe the distribution of tuberculosis cases, the number of TB volunteers, population density, and the number of health service facilities across 11 districts in Southeast Maluku Regency during 2024–2025.

Table 1. Distribution of tuberculosis cases, number of cadres, population density, and number of healthcare facilities in Southeast Maluku Regency (2024–2025)

Sub-district	TB Cases		TB Cadres		Population Density		Healthcare Facilities	
	2024	2025	2024	2025	2024	2025	2024	2025
Kei Kecil	308	248	3	3	0.286	0.267	3	3
Kei Kecil Barat	8	23	1	1	0.081	0.082	1	1
Kei Kecil Timur	21	28	2	2	0.132	0.136	2	2
Hoat Sorbay	7	6	1	1	0.130	0.132	1	1
Manyeuw	29	25	2	2	0.101	0.105	2	2
Kei Kecil Timur Selatan	15	16	1	1	0.105	0.108	1	1
Kei Besar	42	50	4	4	0.178	0.186	4	4
Kei Besar Utara Timur	16	27	2	2	0.081	0.082	2	2
Kei Besar Selatan	10	15	2	2	0.094	0.107	2	2
Kei Besar Utara Barat	10	17	2	2	0.066	0.068	2	2
Kei Besar Selatan Barat	8	8	1	1	0.095	0.097	1	1
Total	474	463	21	21	1.349	1.369	21	21

Source; Secondary Data, 2026

Based on Table 1, the highest number of tuberculosis cases was recorded in Kei

Kecil Sub-district, with 308 cases in 2024 and 248 cases in 2025. Conversely, the lowest number of cases was observed in Hoat Sorbay Sub-district, with 7 cases in 2024 and 6 cases in 2025. Overall, Kei Kecil Sub-district exhibited a substantially higher case burden compared to other sub-districts. Aggregate tuberculosis cases in Southeast Maluku Regency decreased from 474 cases in 2024 to 463 cases in 2025. Nevertheless, several sub-districts demonstrated an upward trend in cases, most notably West Kei Kecil, North-East Kei Besar, North-West Kei Besar, and South Kei Besar. The total number of tuberculosis cadres remained constant at 21 cadres across both observation years. Meanwhile, overall population density increased from 1.349 in 2024 to 1.369 in 2025, with Kei Kecil Sub-district recording the highest population density. The number of healthcare facilities remained unchanged at 21 facilities in both 2024 and 2025. These conditions indicate that population density growth across most sub-districts was not consistently accompanied by a uniform change in tuberculosis cases, thereby necessitating further statistical analysis to evaluate the relationship between population density and tuberculosis incidence.

Relationship between population density and recorded tuberculosis cases in Southeast Maluku Regency (2024–2025)

Based on the Spearman correlation test (Table 2), a *p-value* of 0.029 ($p < 0.05$), was obtained, demonstrating a statistically significant relationship between population density and recorded tuberculosis cases in Southeast Maluku Regency during 2024–2025. The correlation coefficient ($r = 0.466$) indicates a moderate positive correlation, signifying that higher population density corresponds to an increased trend in recorded tuberculosis cases. This finding aligns with [Artanti \(2025\)](#), who reported a positive association between population density and tuberculosis incidence in West Java Province, highlighting that densely populated areas carry a elevated risk of TB transmission due to high interpersonal contact intensity.

Table 2. Recorded tuberculosis cases and population density in Southeast Maluku Regency (2024–2025)

	Incidence of Tuberculosis (TB)		
	N	<i>p-value</i>	<i>r-value</i>
Population Density	22	0.029	0.466

Note: Spearman Correlation Test, significant if $p\text{-value} < 0.05$

These results are further supported by [Ningtyas \(2025\)](#) in Surabaya City, who identified a significant positive Spearman correlation between population density and TB incidence rates. Similarly, [Suryani and Ibad \(2022\)](#) indicated that population density represents an environmental factor associated with increased tuberculosis incidence, as overcrowded living conditions facilitate the transmission of *Mycobacterium tuberculosis*. Furthermore, [Fitri \(2024\)](#) noted that tuberculosis case distribution tends to concentrate in densely populated areas compared to low-density regions. Consistent with these findings, [Afif and Fatah \(2024\)](#) asserted that densely populated areas exhibit higher TB transmission potential owing to heightened daily public mobility and interaction.

[Siahaan et al. \(2020\)](#) explained that housing density and population density contribute to an increased risk of airborne disease transmission, including pulmonary tuberculosis. Additionally, [Kaku et al. \(2024\)](#) identified population density as a key epidemiological determinant influencing the spatial distribution of TB cases in urban environments. This is consistent with infectious disease epidemiology theory, which

postulates that population density elevates airborne transmission probability by increasing inter-individual contact frequency within a given area.

Relationship between the Number of Cadres and Recorded Tuberculosis Cases in Southeast Maluku Regency (2024–2025)

Based on the Spearman correlation test (Table 3), a p -value of 0.001 ($p < 0.05$) was obtained, indicating a statistically significant relationship between the number of cadres and recorded tuberculosis cases in Southeast Maluku Regency during 2024–2025. The correlation coefficient ($r = 0.787$) demonstrates a strong positive relationship. This indicates that a higher number of cadres corresponds to an increased trend in detected and recorded tuberculosis cases. This study aligns with findings by [Pratama and Setiyadi \(2023\)](#), who stated that community health cadres play a pivotal role in TB case-finding behaviors within the community. Health cadres contribute significantly to public education, suspect contact tracing, and patient treatment adherence counseling, thereby optimizing overall case detection.

Table 3. Tuberculosis incidence and the number of cadres in Southeast Maluku Regency (2024–2025)

	Incidence of Tuberculosis (TB)		
	N	p -value	r -value
Number of Cadres	22	0.001	0.787

Note: Spearman Correlation Test, significant if p -value < 0.05

These findings are consistent with [Adawiyah et al. \(2024\)](#), who reported a significant correlation between the knowledge and attitudes of community health cadres and the detection of suspected pulmonary tuberculosis cases at the Senaru Health Center, North Lombok. A literature review by [Pratama \(2021\)](#) highlighted that community health cadres serve as a vital component in community-based active case-finding strategies for tuberculosis, contributing directly to higher case detection coverage. Similarly, [Andrianovita and Gustina \(2022\)](#) demonstrated that cadre motivation positively correlates with successful tuberculosis case finding within primary health center working areas. Furthermore, [Rahayu et al. \(2022\)](#) emphasized that active cadre engagement expands tuberculosis screening coverage through home visits and community health education. Cadres also play a essential role in improving patient adherence to routine medical examinations and treatment regimens. Research by [Putra et al. \(2023\)](#) further indicated that regions with active community health cadres tend to achieve higher tuberculosis case detection rates than those with low cadre involvement. Empowering community health cadres ultimately strengthens community-based tuberculosis surveillance systems, thereby accelerating new case detection.

Relationship between the number of healthcare facilities and recorded tuberculosis cases in Southeast Maluku Regency (2024–2025)

Based on the Spearman correlation test (Table 4), a p -value of 0.001 ($p < 0.05$) was obtained, indicating a statistically significant relationship between the number of healthcare facilities and recorded tuberculosis cases in Southeast Maluku Regency during 2024–2025. The correlation coefficient ($r = 0.787$) demonstrates a strong positive relationship. This indicates that a higher availability of healthcare facilities corresponds to a greater number of recorded tuberculosis cases. This relationship reflects improved access to diagnosis, case detection, and surveillance reporting in regions with more abundant healthcare facilities. Thus, this finding does not imply that

healthcare facilities increase actual tuberculosis incidence, but rather underscores disparities in case detection and reporting capability across regions.

Table 4. Tuberculosis incidence and the number of healthcare facilities in Southeast Maluku Regency (2024–2025)

Incidence of Tuberculosis (TB)			
Variable	N	<i>p-value</i>	<i>r-value</i>
Number of Healthcare Facilities	22	0.001	0.787

Note: Spearman Correlation Test, significant if $p\text{-value} < 0.05$

This study aligns with findings by Wahyudi *et al.* (2025), who stated that improved access to healthcare services and active case finding contribute to increased tuberculosis case detection, particularly among children. These findings are further supported by Pratama and Setiyadi (2023), who demonstrated that the active involvement of healthcare services and community cadres in TB case-finding increases the overall number of cases detected within the community.

The availability of healthcare facilities directly influences public access to early diagnosis and treatment of tuberculosis. Furthermore, Putra *et al.* (2023) observed that regions equipped with more comprehensive healthcare facilities achieved higher TB case-finding coverage compared to areas with limited healthcare access. Similarly, Akbar *et al.* (2026) highlighted that expanding healthcare facility infrastructure enhances the effectiveness of local surveillance and tuberculosis case reporting.

Findings by Dam *et al.* (2022) ndicated that healthcare accessibility correlates with increased TB case detection by facilitating public access to sputum examination and medical consultation. Adhanty and Syarif (2023) further asserted that an equitable distribution of healthcare facilities accelerates case identification and reduces diagnostic delays in pulmonary tuberculosis. Therefore, a higher density of healthcare facilities in a given area enhances community access to TB testing and diagnosis, enabling previously underreported cases to be detected and captured within the health surveillance system.

CONCLUSION

Based on the study findings regarding the relationship of population density, the number of TBC cadres, and the number of healthcare facilities with recorded TBC cases in Southeast Maluku Regency from 2024 to 2025, significant relationships were observed across all evaluated variables. Higher population density corresponds to a trend of increased recorded TBC cases. Likewise, a greater presence of TBC cadres in a region aligns with higher TBC case detection. Similarly, an increased availability of healthcare facilities is associated with higher numbers of detected and recorded TBC cases. Overall, population density, TBC cadre availability, and healthcare facility count demonstrate significant associations with recorded TBC cases in Southeast Maluku Regency during 2024–2025. Among the analyzed variables, the number of TBC cadres and the number of healthcare facilities exhibited the highest correlation coefficients.

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