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The Effect of Close Contact History and Housing Density on the Incidence of Tuberculosis in the Lembeyan Health Center Area, Magetan Regency

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Abstract

Based on a report from the Magetan Regency Health Office in 2021–2023, tuberculosis (TB) cases increased by 309 cases. In the working area of the Lembeyan Health Center, the number of TB cases rose to 33 in 2023–2024. This indicates that TB remains a health problem requiring serious attention. This study aims to analyze the effect of close contact history and housing density on TB incidence. The type of research used is observational analytic with a case-control design. The research sample consisted of 34 respondents, comprising 17 cases and 17 controls, selected using a purposive sampling method. Data were collected through questionnaires and observation sheets. Data analysis was conducted univariately and bivariately using a chi-square test. The results showed a significant association between close contact history (p = 0.002) and housing density (p = 0.016) with the incidence of TB. The conclusion of this study is that there is a significant effect of close contact history and housing density on TB incidence. Therefore, TB prevention should focus on improving residential environmental conditions, providing education to at-risk groups, and monitoring individuals with a history of close contact with TB patients.

Keywords: Tuberculosis, contact history, population density.

INTRODUCTION

Tuberculosis (hereinafter referred to as TB) remains one of the most serious public health problems, both globally and in Indonesia, with case numbers continuing to show high prevalence (Noviyani et al., 2021; Siahaan et al., 2020). This disease is caused by the bacterium *Mycobacterium tuberculosis*, which to date is one of the leading infectious agents causing death worldwide (Sulaiman et al., 2023). These bacteria are able to survive at low temperatures, namely 4ºC to 7ºC, and primarily attack the lungs, but can also invade other organs of the body such as the kidneys, spine, and brain (Sipayung et al., 2023). TB bacteria are rod-shaped and have acid-resistant characteristics; therefore, they are referred to as Acid Fast Bacilli (BTA). In addition to lung infection, TB can also occur outside the respiratory system, known as extrapulmonary tuberculosis. The organs most frequently affected in extrapulmonary TB cases include lymph nodes (lymphadenitis), the pleura, bone tissue, and other organs of the body (Azzahra Hasan et al., 2023).

According to the *Global Tuberculosis Report* published by the World Health Organization (WHO) in 2022, the number of newly diagnosed TB cases showed significant fluctuations in recent years. Between 2017 and 2019, there was a decline of 18%, followed by a sharp decrease between 2019 and 2020, from 7.1 million to 5.8 million cases. A partial recovery was observed in 2021, when 6.4 million cases were recorded (WHO, 2022). Globally,

in 2022, 7.5 million people were newly diagnosed with TB and officially reported, while in 2023 it was estimated that 10.8 million people worldwide were living with TB (WHO, 2023).

In Indonesia, the number of detected TB cases has also fluctuated considerably in recent years. In 2020, a total of 351,936 TB cases were detected—a sharp decrease compared to 2019, when 568,987 cases were reported (Ministry of Health, 2020). However, this trend reversed in 2021, when 397,377 cases were detected (Ministry of Health of the Republic of Indonesia, 2021). A significant increase occurred in 2022, with 677,464 cases detected, and this rise continued in 2023, reaching 821,200 cases—a marked increase compared to the previous year. The provinces with the highest reported TB cases were West Java, East Java, and Central Java, which are also among the most densely populated regions (Ministry of Health, 2023).

According to data from the East Java Provincial Health Profile, TB cases in the province have risen significantly in the past three years (Fitriangga et al., 2025; Lestari et al., 2024; Utomo et al., 2022). In 2021, 43,247 cases were recorded, equivalent to 49.7% of the estimated TB cases in the region. This number rose sharply in 2022, reaching 78,799 cases (82.3%), and continued to increase in 2023 with 87,048 cases (93%). These figures show a consistent upward trend in TB incidence (Dinkesprovjatim, 2023).

Data from the Magetan Regency Health Office show that TB remains one of the most prevalent diseases in the regency, with cases increasing each year. In 2021, 426 TB cases were recorded, rising sharply to 730 in 2022. The number increased slightly again in 2023 to 735 cases. The Case Notification Rate (CNR) in 2023 was 67 cases per 100,000 population. However, despite relatively high case detection, treatment success indicators remain well below national targets. The recovery rate for TB BTA-positive patients was only 33%, falling far short of the national standard of ≥ 85%. Similarly, the overall Treatment Success Rate (TSR) for all TB patients was just 47.8% (Magetan Health Office, 2023).

In the *Lembeyan Health Center* working area, TB has also remained a persistent concern. In 2021, 20 cases were detected, increasing significantly to 42 in 2022. In 2023, cases fell slightly to 33, with the same number reported in 2024. Despite the stabilization, this figure remains high and well below national targets for TB control (Magetan Health Office, 2023). The recovery rate in 2024 for TB patients in the Lembeyan Health Center area was only 34%, while the treatment success rate for all TB patients was just 33%, both falling far below the ≥ 85% target.

One major TB risk factor is close contact with an infected individual. Family members of patients with positive pulmonary TB face a high risk of infection, particularly from droplets or sputum contaminating the air. The closer and more frequent the contact, the greater the likelihood of transmission. Therefore, household members, neighbors, and individuals living with TB patients have a heightened risk of infection (Ariani et al., 2022). In one study, the value of $p = 0.011$ confirmed a significant relationship between household contact history and pulmonary TB incidence in the Serang Kota Health Center area in 2019 (Ariani et al., 2022).

Environmental factors also play a key role in TB spread. The growth of *Mycobacterium tuberculosis* is closely tied to household density. In the Lembeyan Health Center area, the population density reaches 787 persons per km². In crowded households, tuberculosis is more likely to spread due to frequent close contact among residents (Rahayu, 2024). The higher the occupant density, the faster the air becomes contaminated. Increased indoor CO_2 levels further

create favorable conditions for bacterial growth (Muchammad Rosyid, 2023). Research confirmed a statistically significant relationship between housing density (p = 0.006) and TB incidence (Muchammad Rosyid, 2023).

A healthy home environment is critical in preventing TB. Key requirements include properly constructed latrines meeting sanitation standards, safe waste disposal systems, and access to clean water sources. Effective wastewater systems are also essential to prevent environmental contamination. Proper air circulation through adequate ventilation reduces the risk of respiratory diseases. Dwelling density should be proportionate to house size to prevent overcrowding, and house floors should be made of easy-to-clean solid materials such as cement or ceramic, instead of soil floors that harbor germs.

Preventive efforts against pulmonary tuberculosis can be strengthened through improved sanitation, ongoing health promotion, and mass screening programs for early detection. Comprehensive TB control requires integrated cross-sectoral collaboration, strong community engagement, and individual compliance with treatment and healthy lifestyle practices. With such concerted efforts, TB transmission can be significantly reduced. However, the persistent detection of TB cases in the *Lembeyan Health Center* area of *Magetan Regency* highlights the urgent need for further study on the issue brought up.

Previous studies have identified two key risk factors for tuberculosis: household contact and housing density. Ariani et al. (2022) demonstrated a strong association between family contact and pulmonary TB incidence in Serang Kota, confirming interpersonal transmission as a critical factor. Similarly, Rosyid (2023) showed that population density within households accelerates TB spread due to poor ventilation and elevated CO_2 levels. However, most studies to date have focused on singular risk factors or urban environments, without integrating household and environmental elements in semi-rural settings.

This study seeks to address that gap by analyzing the combined effect of close contact history and household density on TB incidence in the Lembeyan Health Center area, Magetan Regency, a semi-rural community with high TB prevalence and limited prior research. Employing a quantitative case-control design, purposive sampling, validated questionnaires, and bivariate statistical analysis, this research aims to provide context-specific evidence linking both household and environmental factors. The findings are expected to inform local public health strategies, strengthen TB prevention efforts, and guide resource allocation in semi-rural health centers, ultimately contributing to reduced TB incidence and improved community health outcomes.

RESEARCH METHOD

This study employed a quantitative observational design with an analytical survey using a case-control approach to examine the effect of close contact history and residential density on the incidence of tuberculosis (TB) at the Lembeyan Health Center, Magetan Regency in 2025. The study population consisted of TB patients diagnosed via TCM as cases (n = 17) and non-TB patients as controls (n = 17), selected based on inclusion and exclusion criteria. Non-probability purposive sampling was applied to ensure respondents met specific characteristics relevant to the research objectives. Primary data were collected through structured interviews

and observations, while secondary data were sourced from health center records and official reports.

Data collection involved administering validated questionnaires to capture information on respondents' close contact history and living conditions. Validity was tested using the r-product moment method on a preliminary sample of 10 respondents, with items exceeding r-table values considered valid. Reliability was assessed using Cronbach's Alpha, with values above 0.60 indicating acceptable internal consistency. All responses were coded numerically and systematically entered into SPSS for processing. Data cleaning, editing, and tabulation ensured consistency, completeness, and accuracy before analysis.

Data analysis consisted of univariate and bivariate techniques to describe variable distributions and examine relationships. Univariate analysis summarized demographic and exposure variables, while bivariate analysis employed chi-square tests to assess associations between risk factors and TB incidence, applying a significance threshold of $\alpha = 0.05$. Odds ratios (OR) were calculated to quantify the strength of associations between exposure and TB outcomes. Cells with expected counts below thresholds were carefully examined to maintain statistical validity, ensuring reliable interpretation of relationships between close contact, residential density, and TB incidence.

RESULTS AND DISCUSSION

The results showed that most of the respondents in the case group had a history of close contact with TB patients, while in the control group most did not have a history of close contact. Bivariate analysis using the Chi-Square test obtained a p value of 0.002 ($p < 0.05$), which means that there is a significant influence between the history of close contact with the incidence of tuberculosis in the work area of the Lembeyan Health Center. Thus, a history of close contact was shown to affect the incidence of TB in this study. These findings indicate that a history of close contact is one of the main risk factors in TB transmission in the community. The largest proportion of the case group having a history of close contact compared to the control group that had no such history reinforces the evidence that TB transmission is strongly influenced by direct and intensive interactions between patients and healthy individuals. In this context, close contact can be defined as physical interaction that is quite close and frequent, especially in a household or community environment

WHO (2023) emphasizes that people living in the same household with TB have a 5–10 times higher risk of contracting it than people without direct exposure. This risk increases if the duration of contact lasts a long time and repeats every day, and occurs in an environment with inadequate air circulation. This condition is very common in densely populated environments or households with low levels of education and health awareness.

The results of this study are in line with the research conducted by (Ria Risti Komala Dewi & Juniyarti, 2021) that there is a relationship between the history of close contact (p value = 0.000) and the incidence of pulmonary tuberculosis at productive age in the working area of the Sungai Durian Health Center. The study also emphasized that a history of close contact is one of the most influential determinants of TB incidence in the region. In this study, a high proportion of cases in respondents with a history of close contact showed that TB transmission in the Lembeyan Health Center Area, Magetan Regency predominantly occurred

through exposure to the outside environment. This indicates that the phenomenon that occurred at the Lembeyan Health Center is not a stand-alone case, but part of a consistent pattern of TB transmission in various regions, especially in the productive age group who are more socially active and have high mobility.

The results of this study are also in line with the research conducted by (Ginting et al., 2024) showing that the p-value is 0.00 ($p<0.05$). This means that there is a meaningful relationship between contact history and the incidence of tuberculosis at productive age (17-59 years) after the covid-19 pandemic at H. Adam Malik Hospital Medan in 2023. The results of the study also showed that the most dominant variable was related to the incidence of Tuberculosis after the Covid-19 pandemic at H. Adam Malik Hospital Medan was the contact history variable with an OR value of 8.87 which means that contact history was 8.8 times more at risk of developing tuberculosis compared to those who did not have a history of contact with tuberculosis patients. This indicates that although social interaction may have decreased during the pandemic, the risk of TB transmission remains high, and may even increase when social restrictions end and community activities return to normal.

Based on the results of observations and interviews in this study, it also revealed that there is a knowledge gap among the public about the mechanism of TB transmission. Some respondents and their families do not even know how and where they could have been exposed to TB, suggesting that a lack of understanding of the disease is one factor that increases the risk of spread. In the case group, most of them are educated at the end of junior high school, this allows for a lack of knowledge and understanding related to TB transmission. In addition, it was also found that neighbors who had been diagnosed with TB and often interacted with respondents were one of the potential sources of close contact.

The researcher assumed that in the control group there were 17.6% of respondents who had a history of close contact with TB patients. It is possible that this happens because even though they have been exposed, the respondents have a good immune system so that the infection does not develop into an active disease. Other factors that may play a role are the existence of effective preventive behaviors, such as the use of masks, adequate home ventilation, or early health checks after contact. This is in accordance with the theory (Kementerian Kesehatan RI, 2020) which states that the risk in individuals with normal immune systems, 90% will not progress to TB disease and only 10% of cases will become active TB disease (half of cases occur immediately after infection and half occur later in life).

Meanwhile, in the case group, 23.5% of respondents were found who did not have a history of close contact with TB patients. This may be due to unidentified sources of transmission, such as exposure in the workplace, school, or public facilities such as shopping centers, so that respondents are unaware of interactions with TB patients. In addition, TB can develop from latent infections that occurred years earlier and only become active when immunity wanes.

Occupancy Density

The results showed that most of the respondents in the case group lived in houses with an ineligible occupancy density, while in the control group most lived in houses with a qualified occupancy density. Bivariate analysis using the Chi-Square test obtained a p value of 0.016 ($p < 0.05$), which means that there is a significant influence between residential density and

tuberculosis incidence in the Lembeyan Health Center area. Thus, residential density was proven to affect the incidence of TB in this study.

Housing density is one of the important indicators in assessing the feasibility of the physical environment of the home, and has a big role in determining the level of exposure to infectious diseases such as TB. Homes inhabited by too many people in a tight space significantly increase the likelihood of TB transmission because air circulation is limited and the accumulation of infectious particles (droplet nuclei) in the air will last longer. The condition of the house is cramped and full of occupants causes droplets to stay longer in the air, so exposure to infection is even higher. In these conditions, other family members become a very vulnerable group to be infected, especially if they live together for a long time without adequate preventive interventions.

The results of this study are in line with the research conducted by (Lestari & Sufa, 2024) that the occupancy density (p-value: 0.042; OR: 6). shows the relationship between residential density and the incidence of Pulmonary TB in the Pringsewu Health Center area in 2023. Research conducted by (Khairani et al., 2020) shows that people who have an unqualified housing density are at a 43,500 times higher risk of experiencing pulmonary TB when compared to people with qualified housing density.

The results of the study are consistent with the TB epidemiological theory that the dense physical environment of the home is one of the important determinants of TB incidence. The majority of the case group lived in an unqualified home that facilitated repeated exposure to TB droplets, while the control group mostly stayed in an eligible home so the risk of transmission was lower.

Based on the findings of field observations, it was found that most of the respondents in the case group did sleep alone, but the rooms occupied were quite narrow, lacked natural lighting, and did not have adequate ventilation. Although only one person occupies a room, the small size of the room and poor air circulation still cause high occupancy conditions. This shows that the definition of occupancy density is not solely calculated from the number of people per room, but also needs to take into account the area of the room, the availability of cross-ventilation, and the air quality in the room. The inverse proportion of the control group is quite good because the majority of the residential density is eligible. Houses with a qualified occupancy density have a protective effect against TB transmission. In addition, the proportion of eligible homes in the control group may also reflect relatively better socioeconomic factors, allowing families to have more livable homes.

Based on the researchers' assumptions, of the 23.5% of respondents in the control group who had an ineligible housing density, they remained protected from the incidence of tuberculosis (TB) caused by several factors. Possible socioeconomic factors varied in the control group. In addition, inefficient use of space can also lead to high occupancy density. Even though the area of the house is sufficient, a less than optimal space layout can cause the available space to not be used optimally, so that residents feel cramped and density seems to increase. However, despite less than ideal or unqualified occupancy density, respondents in the control group did not experience an incidence of tuberculosis due to the possibility of other protective factors, such as adequate ventilation, clean lifestyle, or lack of close contact with TB patients.

Meanwhile, from 29.4% of respondents in the case group who had a qualified housing density but were still infected with TB, it is likely to indicate that housing density is not the only factor influencing transmission. Even though the size of the bedroom is standard and not classically crowded, other risk factors can still cause TB infection such as poor ventilation or rarely opened so that air exchange is not optimal, limited natural lighting, or the habit of tightly closing the room that makes it easier for TB bacteria to survive in the air. Behavioral factors can also contribute, such as smoking habits, not applying proper cough etiquette, or frequent being in enclosed rooms with many people, which increases the risk of transmission even if the conditions of occupancy in the home are qualified.

CONCLUSION

Research conducted in the Lembeyan Health Center area, Magetan Regency, shows that both close contact history and housing density significantly influence the incidence of Tuberculosis, with statistical analysis yielding p = 0.002 and p = 0.016, respectively. Case identification was carried out through symptom tracking (such as cough for more than two weeks, weight loss, and fever), followed by sputum testing, laboratory analysis, and chest X-rays, while new cases were most often discovered through patient visits and close contact tracing. These findings highlight the importance of strengthening community-based active case finding and household-level interventions. Future research should further explore how environmental and behavioral factors, combined with close contact and housing conditions, contribute to TB transmission in semi-rural communities to support more targeted and sustainable control strategies.

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