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The Influence Of Housing Density, History Of Contact With Positive TB Cases, And BCG Immunization History On The Occurrence Of Pulmonary Tuberculosis In Productive Age Individuals

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ABSTRACT
This study aims to analyze the effects of housing density, contact history with pulmonary tuberculosis (TB) patients, and BCG immunization history on the incidence of pulmonary tuberculosis among the productive age group at the Sriwini Community Health Center, Nabire Regency, Central Papua Province, in 2024. This research employs an analytical case-control study design. Data were collected through interviews and medical records of pulmonary TB patients at the community health center.The analysis results indicate that housing density does not have a significant effect on the incidence of pulmonary tuberculosis (P-Value = 1.000), and there is no significant effect of contact history with positive TB patients on pulmonary TB incidence (P-Value = 0.350). However, BCG immunization history was found to have a significant effect on the incidence of pulmonary tuberculosis (P-Value = 0.000). The study concludes that while housing density and contact history do not significantly affect the incidence, BCG immunization history plays an important role in preventing pulmonary tuberculosis among the productive age group in the region.The data collection method relies on interviews and medical records, which depend on the accuracy of information provided by respondents and the quality of medical documentation, potentially leading to information bias. This study contributes to reproductive health knowledge and serves as a reference for preventing and addressing TB health issues in the productive age group.

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INTRODUCTION

Tuberculosis is a directly transmissible disease caused by the bacterium *Mycobacterium tuberculosis*. This bacterium is rod-shaped and acid-resistant, often referred to as Acid-Fast Bacilli (AFB). It primarily attacks the lungs, causing pulmonary tuberculosis (pulmonary TB). However, this bacterium can also affect other organs, such as the lymph nodes, pleura, bones, and others. Pulmonary TB is a contagious disease that spreads through airborne droplets when a TB patient coughs or sneezes, transmitting the bacteria to others. TB bacteria released into the air can survive for a long time, especially in dark and humid environments. As

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a result, individuals who share the same room with pulmonary TB patients are at a higher risk of contracting the disease (Rosdiana, 2019).

Pulmonary TB is a significant problem for developing countries, including Indonesia. Approximately 95% of pulmonary TB patients are in developing nations, with about 89% of cases occurring in adults and 11% in children. To date, TB remains the leading cause of death after HIV/AIDS and is one of the top 20 causes of death worldwide. Indonesia ranks third globally in the number of TB cases, following India and China (WHO, 2021).

The World Health Organization (WHO) reported that the estimated number of TB diagnoses worldwide in 2021 reached 10.6 million cases, an increase of approximately 600,000 cases compared to 2020, when there were an estimated 10 million cases. Of the 10.6 million cases, 6.4 million (60.3%) were reported and treated, while 4.2 million (39.7%) remained undiagnosed and unreported. Among the total cases in 2021, 6 million were adult men, 3.4 million were adult women, and 1.2 million were children. TB-related deaths were alarmingly high, with 1.6 million fatalities, up from 1.3 million in the previous year. Among these, 187,000 deaths were due to both TB and HIV (WHO, 2021).

According to the Global Tuberculosis Report 2021, Indonesia's TB incidence rate in 2020 was 301 per 100,000 population, a decline from 312 per 100,000 in 2019. The TB mortality rate remained consistent at 34 per 100,000 population in both years. In 2021, 397,377 TB cases were recorded, an increase compared to 351,936 cases in 2020. The highest number of cases were reported in provinces with large populations, such as West Java, East Java, and Central Java. These three provinces accounted for 44% of the total TB cases in Indonesia. Male patients outnumbered females nationally and provincially, with men accounting for 57.5% of cases and women 42.5% (WHO, 2021).

The Case Notification Rate (CNR) in Indonesia's health profile for 2021 also increased, from 130/100,000 population in 2020 to 146/100,000 in 2021. This indicates a rise in the total number of reported and treated pulmonary TB cases per 100,000 Indonesians. The provinces with the highest CNR were Papua (268/100,000), Jakarta (263/100,000), and Gorontalo (223/100,000). The Treatment Success Rate (TSR) is an indicator used to evaluate TB treatment effectiveness. The national TSR in 2021 reached 86.0%, surpassing the Ministry of Health's target of 85%. However, many provinces, including Papua, failed to meet this target, with Papua recording a TSR of 72% (Ministry of Health, Republic of Indonesia, 2021).

The Papua Provincial Health Office's 2021 Profile reported 25,689 positive TB cases in Papua, an increase from 11,532 cases in 2020. Most cases (92%) occurred in the productive age group (15–50 years), while 8% were among children aged 0–14 years. The TB recovery rate in Papua was very low in 2021, with only 874 men (37.3%) and 706 women (38.5%) recovering. Poor adherence to the TB treatment program significantly impacted the recovery rate. Based on the background above, it is crucial to conduct research on the Influence of Housing Density, History of Contact with Positive TB Patients, and BCG Immunization History on the Incidence of Pulmonary Tuberculosis in the Productive Age Group.

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METHODS

The research method used in this study is observational analytics with a case-control study design. A case-control study is an analytical survey that examines risk factors using a "retrospective" approach. In other words, the effects (disease or health status) are identified in the present, and the risk factors are traced back to their presence or occurrence in the past (Gahayu, 2019).

This study was conducted in the working area of Sriwini Health Center, Nabire Regency, Central Papua Province. The research took place from July to September 2024. The case population in this study consisted of all patients who underwent microscopic tests at Sriwini Health Center in 2023 and up to July 2024, with sputum test results indicating pulmonary TB with positive AFB (+), residing in the working area of the Sriwini Health Center, totaling 50 individuals. The control population comprised all patients who underwent microscopic tests at Sriwini Health Center in 2023 and up to July 2024, with sputum test results indicating negative pulmonary TB, totaling 100 individuals.

The case sample in this study was selected using a total sampling technique, meaning the entire case population became the study sample. The case group in this study consisted of 50 respondents who were pulmonary TB patients. For the control sample, the number was determined using a 1:2 ratio of case to control groups. Thus, the control sample consisted of 100 respondents who were negative pulmonary TB patients. The control samples were selected using purposive sampling with a matching process.

Univariate analysis was conducted for each variable and the study results. This type of analysis is used to describe the characteristics of each variable studied (Notoatmodjo, 2014). Univariate analysis was performed to describe all research variables by creating frequency and percentage distributions for each variable.

Bivariate analysis was conducted to determine the effect between independent and dependent variables. Given that the measurement scale for the variables in this study was ordinal and nominal, the chi-square test and odds ratio (OR) calculation were used. This analysis aimed to identify statistically significant relationships between independent and dependent variables with a significance level of 0.05 or $\alpha = 5\%$ (Gahayu, 2015).

Data analysis was performed with a significance threshold of $\alpha = 0.05$. If the p-value $\leq \alpha$, then the null hypothesis (Ho) is rejected, indicating a significant relationship between the independent and dependent variables. Conversely, if the p-value $> \alpha$, the null hypothesis (Ho) is accepted, meaning no significant relationship exists between the independent and dependent variables.

RESULTS AND DISCUSSION

Respondent Characteristics

The characteristics of the respondents in this study, both from the case group and the control group, are shown in the table below:

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https://ejournal.seaninstitute.or.id/index.php/healt

Table 1. Respondent Characteristics

Variable		Case		Control	
		N	%	N	%
Age					
	15-64 Year	44	88	100	100
	<15 & >Year	6	12	0	0
Sex					
	Male	29	58	31	31
	Female	21	42	69	69
Smoking					
	Yes	23	46	25	25
	No	27	54	75	75

Based on the data in Table 1 above, it is known that the most common age group in the case group is the productive age, with 44 people (88%), while in the control group, all 100 people (100%) are in the productive age range. The gender distribution shows that the majority in the case group are male, with 29 people (57%), while in the control group, the majority are female, with 69 people (69%). In terms of smoking behavior, the case group has 23 smokers (46%) and the control group has 25 smokers (25%). Regarding contact with TB patients, the case group has 9 individuals (18%) with a history of contact, while the control group has 11 individuals (11%).

The Relationship Between Pulmonary Tuberculosis Incidence and Housing Density at Sriwini Health Center, Nabire Regency

The analysis of the relationship between pulmonary tuberculosis incidence and housing density at Sriwini Health Center, Nabire Regency, can be seen in the table below:

Table 2. The Relationship Between Pulmonary Tuberculosis Incidence and Housing Density at Sriwini Health Center, Nabire Regency

Housing Density	TB				P-Value
	Case		Control		
	N	%	n	%	
Not Meeting Requirements	33	66	66	66	
Meeting Requirements	17	34	34	34	*1.000*
Total	50	100	100	100	

Table 2 shows that the highest percentage is found among those with housing density that does not meet the requirements, both in the case group (66%) and the control group (66%). The lowest percentage is found among those with housing density that meets the requirements, both in the case group (34%) and the control group (34%). For the housing density variable, the statistical test yielded a P-value of 1.000. Since the P-value is greater than 0.05, this indicates that housing density does not have a significant impact on the incidence of pulmonary tuberculosis.

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https://ejournal.seaninstitute.or.id/index.php/healt

Analysis of the Relationship Between Pulmonary Tuberculosis Incidence and Contact with Pulmonary Tuberculosis Patients at Sriwini Health Center, Nabire Regency

The analysis of the relationship between pulmonary tuberculosis incidence and contact with pulmonary tuberculosis patients at Sriwini Health Center, Nabire Regency, can be seen in the table below:

Table 3: Relationship Between Pulmonary Tuberculosis Incidence and Contact with Pulmonary Tuberculosis Patients at Sriwini Health Center, Nabire Regency

History of contact with TB patients	TB				P-Value
	Case		Control		
	n	%	n	%	
Yes	9	18	11	11	
No	41	82	89	89	*0.350*
Total	50	100	100	100	

Table 3 shows that the highest percentage is found among those who have no history of contact with TB patients, both in the case group (82%) and the control group (89%). The lowest percentage is found among those with a history of contact with TB patients, in both the case group (18%) and the control group (11%). For the variable of having a history of contact with TB patients, the statistical test yielded a P-value of 0.350. Since the P-value is greater than 0.05, this indicates that the variable of contact history with TB patients does not have a significant impact on the incidence of pulmonary tuberculosis.

Analysis of the Relationship Between Pulmonary Tuberculosis Incidence and BCG Immunization History at Sriwini Health Center, Nabire Regency

The analysis of the relationship between pulmonary tuberculosis incidence and BCG immunization history at Sriwini Health Center, Nabire Regency can be seen in the table below:

Table 4: Distribution of Pulmonary Tuberculosis Incidence Based on BCG Immunization History at Sriwini Health Center, Nabire Regency

History Of BCG immunization	TB				P-Value
	Case		Control		
	n	%	n	%	
No	30	60	15	15	
Yes	20	40	85	85	*0.000*
Total	50	100	100	100	

Table 4 shows that the highest percentage is found in those with no history of BCG immunization (60%) in the case group. In contrast, 85% of the control group had a history of BCG immunization. For the BCG immunization history variable, statistical testing revealed a p-value of 0.000. Since the p-value is less than 0.005, it indicates that the BCG immunization history variable significantly influences the incidence of pulmonary tuberculosis.

Jurnal Eduhealth
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https://ejournal.seaninstitute.or.id/index.php/healt

Discussion

The Relationship Between Pulmonary Tuberculosis Incidence and Housing Density at Sriwini Health Center, Nabire Regency

Housing density refers to the ratio between the floor area of a house and the number of family members living in it. A mismatch between the size of the house and the number of occupants can lead to overcrowding, meaning the floor area should accommodate the number of residents to prevent overload. Overcrowding can result in insufficient oxygen consumption and facilitate the transmission of infectious diseases among family members. Housing density requirements for all houses are generally expressed in square meters per person. The minimum floor area per person is relative and depends on the quality of the building and the facilities available. For simple housing, the minimum area is 8 m² per person (Yunis MY, 2018).

Based on the analysis results, 66% of pulmonary TB patients lived in homes with housing densities that did not meet the requirements. However, the statistical test results showed a P-value of 1.000. Since the P-value is greater than 0.05, it indicates that housing density does not significantly influence the incidence of pulmonary tuberculosis.

This finding aligns with research conducted by Damayati D.S., et al., in 2018 at the Liukang Tupabbiring Health Center, Pangkep Regency, where statistical testing using the chi-square test resulted in a P-value of 0.747 (P-value > 0.05). This means there was no significant relationship between housing density and the incidence of pulmonary TB.

Factors influencing housing density include the house's floor area and the number of occupants. Observations revealed that the number of occupants ranged from 3 to 6 people, while the respondents' house floor areas ranged from 35 to 85 m². On average, each house was inhabited by 4 people, with 1–2 people per bedroom. Based on these observations, most respondents' housing densities met the required standards.

While overcrowded living conditions are often considered a potential risk factor for TB transmission due to increased exposure to airborne droplets, this study found that most respondents had housing conditions meeting the minimum space standards. Observations revealed that the average number of occupants per household and the allocation of room space were generally adequate, reducing the likelihood of overcrowding contributing to TB transmission.

These findings highlight the importance of other potential factors, such as individual immunity, environmental conditions, and adherence to preventive measures, in influencing TB incidence. Public health efforts should continue to focus on comprehensive TB prevention strategies, including early diagnosis, treatment adherence, and public education on reducing risk factors for TB transmission. Further studies are recommended to explore other environmental and behavioral determinants of TB incidence in the region, providing a broader understanding to support more targeted and effective TB control programs.

Analysis of the Relationship Between Pulmonary Tuberculosis Incidence and Contact with Pulmonary Tuberculosis Patients at Sriwini Health Center, Nabire Regency

Contact history refers to any physical or non-physical interaction with a tuberculosis (TB) patient. Individuals with family members who have tested positive for pulmonary TB are

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at greater risk of transmission through exposure to droplet aerosols. Pulmonary TB patients with positive AFB (Acid-Fast Bacilli) results pose a higher risk of transmission compared to those with negative AFB results. The annual risk of transmission is indicated by the Annual Risk of Tuberculosis Infection (ARTI), which represents the proportion of the population at risk of TB infection within one year (Darmin, 2020).

The analysis revealed that respondents in both the case group and the control group predominantly did not have contact history with TB patients: 82% in the case group and 89% in the control group. Statistical testing on the variable "contact history with TB patients" produced a P-value of 0.350, which is greater than 0.05. This indicates that contact history with TB patients does not significantly influence the incidence of pulmonary TB.

This finding aligns with the study conducted by Erni Rita in 2020, which analyzed the relationship between contact and pulmonary tuberculosis incidence in children. Statistical testing in that study produced a P-value of 0.389, leading to the conclusion that there was no significant relationship between contact with TB patients and pulmonary tuberculosis incidence in children.

However, this study contrasts with the findings of Evi Nopita et al. (2023). Their statistical analysis showed a P-value of 0.000, which is smaller than the significance level (α = 0.05). They concluded that there was a significant relationship between contact history and pulmonary TB incidence. Their analysis also yielded an odds ratio (OR) of 0.120, indicating that respondents with a contact history with pulmonary TB patients were 0.120 times more likely to develop pulmonary TB than those without such contact history.

A person may develop TB due to Mycobacterium tuberculosis bacteria, which is influenced by the concentration of droplets in the air and the duration of exposure in that area (Damayati, Susilawaty, and Maqfirah, 2018). Thus, prolonged exposure to high concentrations of droplets increases the likelihood of bacteria entering the lung tissue (Farrah et al., 2020). If the body's condition is strong, dormant bacteria in the lung tissue may remain inactive for months or years. However, these bacteria may become active during periods of weakened immunity, leading to illness referred to as post-primary TB infection (Fitrianti, Wahyudi, and Murni, 2022).

The results of this study, which found no significant relationship between contact history and pulmonary TB incidence, may be attributed to the lengthy pathological process of TB as explained above. It often takes months or even years for an individual to develop pulmonary TB, even with frequent contact with TB patients. Furthermore, if supported by a strong immune system, the likelihood of transmission in the near term is significantly reduced.

Although contact with TB patients is generally considered a risk factor for transmission, several factors may explain the lack of a significant relationship in this study. These include the duration and intensity of exposure, the protective measures taken by individuals, and the role of individual immunity in preventing infection. Additionally, TB transmission may occur over a prolonged period, with latency extending for months or even years before symptoms manifest.

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The findings underscore the importance of strengthening TB prevention and control measures, including improving public awareness about TB transmission, promoting early detection and treatment of TB cases, and ensuring that individuals in close contact with TB patients receive appropriate screening and preventive interventions. Further research is recommended to explore other potential factors influencing TB transmission in the region, such as environmental conditions, socioeconomic status, and community health practices, to enhance the effectiveness of TB control programs.

Analysis of the Relationship Between Pulmonary Tuberculosis Incidence and BCG Immunization History at Sriwini Health Center, Nabire Regency

Tuberculosis is one of the diseases that can be prevented through immunization. BCG immunization is provided as part of the Immunization Development Program implemented by the Indonesian Ministry of Health, targeting infants aged 0–2 months. Administering the BCG vaccine to infants older than two months requires a tuberculin test to determine if the infant has been exposed to Mycobacterium tuberculosis. The primary purpose of the BCG vaccine is to prevent TB. However, over more than 90 years of BCG vaccination, studies have shown varied results regarding its efficacy. The protective effect of the BCG vaccine lasts for about 10 years in children. The efficacy of the BCG vaccine ranges from 0% to 80% across different populations worldwide (Tafreshi S, 2016).

The analysis revealed that 60% of pulmonary TB respondents did not have a history of BCG immunization, while 85% of the control group had a history of BCG immunization. Statistical testing on the variable "history of BCG immunization" produced a P-value of 0.000, which is less than 0.005. This indicates that the variable "history of BCG immunization" significantly influences the incidence of pulmonary TB. These findings align with research conducted by Titus et al. (2019), which stated that a history of BCG immunization is a risk factor for pulmonary TB incidence in the working area of Biromaru Health Center, Sigi Regency.

According to the researcher's assumption, individuals with a history of BCG immunization develop active immunity in their bodies, which enables them to respond to the presence of tuberculosis bacteria. However, the study also found that some individuals with a history of immunization still contracted pulmonary TB. This could be due to several factors Partial Immunity: Immunity provided by the BCG vaccine is not 100% effective. Nutritional Status: Adequate nutrition significantly supports the body's defense against pulmonary TB. Age Factor: The immunity provided by the BCG vaccine is most effective in early childhood. Most TB patients are older adults and the elderly, meaning the immunity gained from the vaccine may no longer be effective. Additionally, the odds ratio analysis showed that a history of BCG immunization is a risk factor for pulmonary TB incidence, highlighting its importance in disease prevention.

Despite its protective effects, the BCG vaccine does not provide absolute immunity, as some individuals with a history of immunization were still found to have contracted TB. Factors such as declining immunity with age, suboptimal nutritional status, and the partial effectiveness of the vaccine may contribute to this outcome. Furthermore, the vaccine's protective effect is most pronounced during early childhood, and its efficacy diminishes over time.

Jurnal Eduhealth
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https://ejournal.seaninstitute.or.id/index.php/healt

These findings highlight the critical role of BCG immunization in reducing the risk of pulmonary TB while emphasizing the need for complementary efforts, including improved nutritional intake, regular health monitoring, and TB prevention programs targeted at vulnerable populations, particularly adults and the elderly. Continued public health education and vaccination campaigns are essential to strengthen TB prevention and control efforts in the region.

CONCLUSION

First, in terms of housing density, no significant influence was found between housing density and the incidence of pulmonary tuberculosis (TB) at Sriwini Health Center, Nabire Regency, Central Papua Province, in 2024. This suggests that housing density does not directly contribute to an increased risk of pulmonary TB in this region.Second, regarding household contact with pulmonary TB patients, no significant relationship was identified between household contact with TB-positive patients and the incidence of TB at Sriwini Health Center. While household contact can increase the likelihood of TB transmission, this study indicates that other factors may play a more dominant role in the occurrence of pulmonary TB in the area. Finally, BCG immunization history was found to have a significant relationship with the incidence of pulmonary TB. The study confirms that BCG immunization plays a crucial role in reducing the risk of pulmonary TB, offering protection to individuals who have received the vaccine. In conclusion, while factors like housing density and household contact do not significantly affect the incidence of pulmonary TB in this region, the history of BCG immunization stands out as a critical factor in preventing the disease within the Sriwini Health Center area.

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