



## Risk Factor Analysis of Latent Tuberculosis Infection in Mamuju Tengah Regency

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### KEYWORDS

Latent TB Infection, DM, Nutritional Status, BCG Vaccine, Residential Density, Home Ventilation

### ABSTRACT:

**Introduction:** Infectious latent TB (ILTB) has been recognized as one of the greatest barriers to achieving the goals of the End TB Strategy. The burden of Infectious Latent Tuberculosis (ILTB) in the world in 2019 is estimated at 1.7 billion people of which 35% are from the Southeast Asia region including Indonesia. Data from the West Sulawesi Provincial Health Office reported an estimated 7,241 cases of Latent TB Infection. Mamuju Tengah district is an area that contributes to the incidence of TB, which is 164 per 100,000 population. The data shows that the risk of TB Latent Infection is estimated at 682 people, but out of a total of 125 TB Latent Infection target screenings, there were 43 positive cases using the Tuberculin test.

**Objectives:** This study aims to determine the risk factors for the incidence of Latent TB Infection in Central Mamuju Regency.

**Methods.** This research is a quantitative study with an analytical survey approach, with a *Case Control Study* design. The sampling technique used exhaustive sampling using the *Lemeshow* formula (1990).

**Results:** The results were analyzed using the *chi-square* test and logistic regression test. The results of the study on the variables of DM disease status (OR = 6.428 with 95% CI = 2.124-20.627), nutritional status / IMT (OR = 1.802, with 95% CI = 0.739-4.339) BCG Vaccine History (OR = 6.637 with 95% CI = 2.633-17.037), house occupancy density (OR = 5.660 with 95% CI = 12.252-14.309) and house ventilation (OR = 5.052 with 95% CI = 2.048-12.566). The results of logistic regression analysis showed that the history of BCG vaccine administration was the main risk factor for the incidence of latent TB infection in Mamuju Tengah district.

**Conclusions:** Risk factors for latent TB infection were DM status, BCG vaccine history, house density and house ventilation. Increased logistical availability of Tuberculin testing in risk groups needs to be widespread to reach more Latent TB cases in Mamuju Tengah District.

### 1. Introduction

The World Health Organisation (WHO) estimates that around a quarter of the world's population is latently infected by *Mycobacterium Tuberculosis* and at risk of developing active TB disease. The global burden of latent tuberculosis infection (ILTB) in 2019 is estimated to be 1.7 billion people, 35% of whom are from Southeast Asia, including Indonesia. About 5-10% of people with ILTB will develop active TB, usually within

5 years of first infection. In 2021, the number of people diagnosed with TB globally will be 10.6 million cases, an increase of about 600,000 cases from the estimated 10 million cases in 2020 .1

Infectious latent TB (ILTB) has been recognised as one of the biggest barriers to achieving the goal of an end TB strategy. A systematic study of 11 studies in Southeast Asia showed that 24.4% to 69.2% of children under 15 years of age come into contact with an active



TB person and 3.3% to 5.5% of them will develop active TB. The risk is higher in immunocompromised individuals, such as those with HIV, diabetes, and respiratory infections. 2

Indonesia in 2019 is estimated to have around 1.7 million cases of Latent Tuberculosis Infection in contact with active TB cases and other at-risk populations.3 Indonesia is currently in the second position (2nd) with the highest number of TB patients in the world after India and China. Active TB cases in Indonesia are estimated at 969,000 TB cases. This figure increased 17% from 2020, which was 824,000. The case incidence is 354 per 100,000 population.4

Data from the West Sulawesi Provincial Health Office reported a TB Case Detection Rate in 2022 of 2810 cases, which is 56% of the target number of cases, an increase compared to 2021 of 2032 cases or 40.4% of the estimated number of cases. Estimated cases of latent TB infection are 7,241 people.

Central Mamuju District is an area that contributes to the incidence of TB in West Sulawesi Province. In 2022 the TB case detection rate was 214, in 2021 it was 227 cases. TB case incidence is 164 per 100,000 population. The data shows the risk of Latent TB Infection is estimated to be 682 people, but from a total of 125 screening targets for Latent TB Infection, 43 positive cases were using the Tuberculin test (DHO Mamuju Tengah, 2023). One of the risks of TB infection is the occurrence of comorbid TB-DM in individuals, although TB is more closely associated with other immune deficiency diseases such as HIV, but the number of people with diabetes is much greater. This makes diabetes mellitus a more significant risk factor for TB at the population level.5 In 2022 in Mamuju Tengah Regency, the number of cases of Diabetes Mellitus was 840 cases, so it can be one of the risks of increasing TB cases and latent TB infection.

A research study conducted in Cocle Province, Panama, showed a prevalence of latent TB infection of 11.5%, suggesting that overweight and elderly people have a higher risk of latent TB infection. The opposite malnutrition status of low BMI did not show an increase in ILTB cases. So it can be argued that overnutrition could be a potential risk factor for TB Latent Infection.6

Administration of the Bacille Calmette-Guerin (BCG) vaccine is necessary to protect against TB, especially in

high TB burden countries, including Indonesia, due to its high protective effect (60-80%) against TB disease. BCG vaccination is considered effective in reducing the risk of TB in adults.7 A study conducted by Huang et al. in China showed an association between latent TB infection and BCG vaccination in freshmen at Hunan University in China. In addition, BCG appeared to have a protective effect on freshmen against latent TB infection with an estimated effectiveness of 74%.

Houses that are densely populated and have inadequate ventilation cause the air circulation in the house to be unhealthy, because many residents can affect the oxygen levels in the house. This leads to an increase in the number of microorganisms that cause disease through the respiratory tract. The more occupants in the house, the more the number of microorganisms.8 A study conducted by showed that house ventilation, occupant density, BCG status, economic status, had a significant relationship with the incidence of latent TB in household contacts with TB patients. 7

Given the various risks of TB transmission, transmission in the community is also high. The organisation of TB patient care should ensure that all people with a history of contact with TB patients are screened. Preventing the progression of latent TB infection to active TB disease is an important public health goal that substantially reduces TB transmission. An important part of the End TB Strategy is targeted treatment for those who are infected and at risk of progressing to active TB disease. Therefore, in line with the increase in TB cases in Central Mamuju District, which may also increase the estimated number of TB Latent Infection cases, it was deemed necessary to conduct a research study of risk factors that may be associated with the finding of TB Latent Infection cases in Central Mamuju District.

## Research Methods

### Study Design

This study was conducted in Mamuju Tengan District, West Sulawesi Province. This study used a case control study design to determine the risk factors for the incidence of TB Latent Infection.

### Population and Sample

The population in this study were people who had contact with TB patients in the Puskesmas Working Area in Mamuju Tengah Regency who had been



examined using the Tuberculin skin test and recorded in the Puskesmas ILTB register in October 2022 to April 2023, totalling 124 people and the whole was sampled using the lamesshow formula.

### Research Variables

The dependent variable was latent TB infection. The independent variables consisted of DM Disease Status, Nutritional Status/IMT, BCG Vaccine History, Residential Density and Home Ventilation.

### Data Collection

Data collection was carried out through the interview method by visiting each respondent's home and making observations or direct observations of the respondent's home conditions. Researchers took about 15-30 minutes to interview each respondent. The measuring instruments used during data collection were questionnaires and observation sheets.

### Data Analysis

The association and magnitude of risk factors between dependent and independent variables were analysed using the *chi-square* test. The multivariate analysis used was the logistic regression test with a *confidence level of 95%* ( $\alpha = 0.05$ ).

### Ethics Approval

This study was approved by the Health Research Ethics Committee of Hasanuddin University with ethical approval recommendation number 4639/UN4.14.1/TP.01.02/2023. *Informed consent* was obtained from all research respondents, data confidentiality was maintained and privacy was guaranteed.

### Results

#### Respondent Characteristics 1.

Distribution Based on Characteristics of Latent TB Infection Respondents in Mamuju Tengah Regency

Year 2023

Latent Infection TB Respondent Characteristics	Case		Control		Total	
	n	%	n	%	n	%
	<b>Gender</b>					
Male	14	35,9	22	27,85	36	30,51
Women	25	64,10	57	72,15	82	69,41

### Age (years)

14-25	4	10,26	16	20,26	20	16,95
26-35	9	23,08	26	32,91	35	29,66
36-45	12	30,77	13	16,46	25	21,19
46-55	8	20,51	12	15,19	20	16,95
56-65	4	10,26	8	10,13	12	10,17
>60	2	5,13	4	5,06	6	5,08

### Education

Not in School	0	0	6	7,59	6	5,08
Finished primary school	7	17,95	16	20,25	23	19,49
Completed junior high school	6	15,38	11	13,92	17	14,41
Completed high school	7	17,95	15	18,99	22	18,64
College Graduate	19	48,72	21	39,24	50	42,37

### Jobs

PNS/TNI/POLRI	14	35,9	22	27,85	36	30,51
Self-employed	0	0	7	8,86	7	5,92
Farmer/Labourer	10	25,64	14	17,72	24	20,34
Student	1	2,56	6	7,59	7	5,92
IRT	6	15,38	21	26,58	27	22,88
More	8	20,51	9	11,39	17	14,41

Table 1 above shows that the respondents were mostly female with a proportion of 69.41%. In the case of latent TB infection, there were more females with a proportion of 64.10%. Likewise, the controls were mostly female with a proportion of 72.15%.

Based on the age of the respondents, most of them were in the age group of 26-35 years with a proportion of 29.66%. In the case group, latent TB infection was mostly in the age group of 36-45 years with a proportion of 30.77%. While in the control group, most were in the age group of 26-35 years with a proportion of 32.91%. Most of the respondents' education graduated from university with a proportion of 42.37%. As for the latent TB infection case group, most of them graduated from college with a proportion of 48.72%. The control group also mostly graduated from college with a proportion of 39.24%. Most of the respondents' occupations were civil servants with a proportion of 30.51%. In the latent TB infection case group, most worked as civil servants with a proportion of 35.90%. In the control group, most also worked as civil servants with a proportion of 27.85%.



## Research Variables

**Table 2.**

Distribution Based on Research Variables on Latent TB Infection in Mamuju Tengah Regency

Year 2023

Latent TB infection	Total				Total	
	Case		Control		n	%
Research Variables	n	%	n	%	n	%
<b>DM status</b>						
High	15	38,46	7	8,86	22	18,64
Low	24	61,54	72	91,14	96	81,36
<b>Nutritional Status/ IMT</b>						
High	16	41,03	22	27,85	38	32,20
Low	23	58,97	57	72,15	80	67,80
<b>BCG history</b>						
High	27	69,23	20	25,32	47	39,83
Low	12	30,77	59	74,68	71	60,71
<b>Residential Density</b>						
High	23	58,97	16	20,25	39	33,05
Low	16	41,03	63	79,75	79	66,95
<b>Home Ventilation</b>						
High	24	61,54	19	24,05	43	36,44
Low	15	38,46	60	75,95	75	63,56

Source: Primary Data, 2023

Table 2 above shows that the variable of Diabetes Mellitus disease history status in respondents was mostly low risk in the control group (91.14%), while in the case group, most were at low risk (61.54%). Nutritional status variables based on Body Mass Index (BMI) were mostly low risk in the control group (72.15%) and in the case group most were low risk (58.97%). The BCG vaccine history variable was mostly

low risk in the control group (74.68%) and high risk in the case group (69.23%). The variable of house occupancy density was mostly low risk in the control group (79.75%) and high risk in the case group (58.97%). The home ventilation variable was mostly low risk in the control group (75.95%) and high risk in the case group (61.54%).



## Bivariate Analysis

**Table 3. Risk Factors for Latent TB Infection in Mamuju Tengah District  
Year 2023**

Research Variables	Latent TB infection				P	Total	
	Case		Control			OR	CI 95%
	n	%	n	%			
<b>History of DM</b>							
<b>High</b>	15	38,46	7	8,86	0.000	6,428	2,124-20,627
<b>Low</b>	24	61,54	72	91,14			
<b>IMT</b>							
<b>High</b>	16	41,03	22	27,85	0.149	1,802	0.739-4,339
<b>Low</b>	23	58,97	57	72,15			
<b>BCG history</b>							
<b>High</b>	27	69,32	20	25,32	0.000	6,637	2,633-17,037
<b>Low</b>	12	30,77	59	74,68			
<b>Residential Density</b>							
<b>High</b>	23	58,97	16	20,25	0,000	5,660	2,252-14,309
<b>Low</b>	16	41,03	63	79,75			
<b>Home Ventilation</b>							
<b>High</b>	24	61,54	19	24,05	0,000	5,052	2,048-12,566
<b>Low</b>	15	38,46	60	75,95			

Source: Primary Data, 2023

Table 3 shows that the DM disease status variable has an Odds Ratio (OR) value of 6.428 (CI 95%: 2.124-20.627) with lower limit and upper limit (LL-UL) values not covering the value of 1. Based on these data, it shows that Diabetes mellitus status is a significant risk factor for the incidence of Latent TB Infection in Central Mamuju Regency. So it can be concluded that respondents who experience diabetes mellitus (high risk category) are 6.428 times more likely to experience TB Latent Infection compared to respondents who do not experience DM disease (low risk category).

Based on the results of the analysis on the nutritional status/IMT variable, the Odds Ratio (OR) value is 1.802 (CI 95%: 0.739-4.339) with the lower limit and upper limit (LL-UL) values including the value of 1. This means that body mass index is a risk factor that is not meaningful for the incidence of Latent TB Infection in Central Mamuju District.

Based on the results of the analysis on the variable history of BCG vaccine administration, the Odds Ratio (OR) value is 6.637 (CI 95%: 2.633-17.037) with the lower limit and upper limit (LL-UL) values not including the value of 1, which means that the history of



BCG vaccine is a significant risk factor for the incidence of Latent TB Infection in Mamuju Tengah Regency. It can be concluded that respondents who did not have a history of BCG vaccine (high risk category) were 6.637 times more likely to experience TB Latent Infection compared to respondents who had a history of BCG vaccine (low risk category).

Based on the results of the analysis on the variable of house occupancy density, the Odds Ratio (OR) value is 5.660 (CI 95%: 2.252-14.309) with the lower limit and upper limit (LL-UL) values not covering the value of 1, which means that house occupancy density is a significant risk factor for the incidence of Latent TB Infection in Central Mamuju Regency. So it can be concluded that respondents who have high residential density (high risk category) are 5.660 times more likely to experience TB Latent Infection compared to respondents in the low risk category.

Based on the results of the analysis on the home ventilation variable, the Odds Ratio (OR) value is 5.052 (CI 95%: 2.048-12.566) with a lower limit and upper limit (LL-UL) value that does not cover the value of 1, which means that home ventilation is a significant risk factor for the incidence of Latent TB Infection in Central Mamuju Regency. So it can be concluded that respondents whose home ventilation does not meet the requirements (high risk category) are 5.052 times more likely to experience TB Latent Infection compared to respondents in the low risk category.

**Multivariate Analysis**

Table 4. Summary of the Results of Bivariate Analysis of the Incidence of Latent TB Infection in Mamuju Tengah Regency in 2023

Research Variables	OR	CI 95% (LL - LU)	P-value
DM status	6,428	2,124-20,627	0.000
Nutritional Status/ DM	1,802	0.739-4,339	0.149
BCG Vaccine History	6,637	2,633-17,037	0.000
Residential Density	5,660	2,252-14,309	0.000
Home Ventilation	5,052	2,048-12,566	0.000

Source: Primary Data, 2023

Table 4 shows that the variables of DM status, BCG vaccine history, residential density and ventilation of the drug house and drug side effects were included in the multivariate analysis because they had statistically significant OR values. As for the variable Nutritional Status/IMT, although the OR value was not statistically

significant, the significant value was <25, so multivariate analysis was also conducted.

Table .5 Results of Multivariate Analysis of Risk Factors for Latent TB Infection in Mamuju Tengah Regency in 2023

Variables	p-value	OR	95% CI
DM status	0,117	2,681	0,781 - 9,199
Nutritional Status/IMT	0,210	1,983	0,679 - 5,787
BCG Vaccine History	0.001	5,220	1,888 - 14,443
Residential Density	0,158	2,426	0,706 - 8,337



Home ventilation	0,091	2,853	0,845 - 9,622
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Based on the results of multivariate analysis in table 5, it shows that the only variable that has a p value <0.05 is the BCG vaccine history variable. When viewed from the OR value, it shows that of the four variables that have a meaningful value, the BCG vaccine history variable has the largest OR value, so it can be interpreted that the variable that is very influential in the incidence of Latent TB Infection in Mamuju Tengah Regency is the BCG vaccine history (p-value 0.001) with OR = 5.220.

## Discussion

### 1. Risk Factors of Diabetes Mellitus Disease Status for Latent TB Infection.

Diabetes mellitus (DM) is a chronic metabolic disease characterised by elevated blood glucose (or blood sugar) levels, which can compromise an individual's immunity and increase susceptibility to a variety of infectious diseases, including TB, both active and latent.

Based on the results of univariate and bivariate analysis on the variable of Diabetes Mellitus disease history status, it shows that out of 118 respondents, most of them are at low risk in the control group (91.14%), while in the case group most of them are at low risk (61.54%) This study found that respondents whose DM disease status is in the high risk category can increase the risk of 6.428 times experiencing Latent TB Infection compared to respondents who do not suffer from DM Disease (low risk category).

DM disease status in respondents was known through interviews using a questionnaire. DM status in this study is categorised as high risk if the respondent has been diagnosed by a health worker with DM and categorised as low risk if the respondent has never been diagnosed with DM. Based on the researcher's interview with the respondent, the diagnosis of DM was made prior to the Tuberculin test examination in the patient. Respondents' DM conditions mostly come from family history, then irregular diet and exercise.

This study is in line with research conducted by Qiaou Liu, et al (2022) that the risk of latent TB infection was found to increase by 60% in DM patients, compared to people who did not experience DM.

Diabetes mellitus (DM) is one of the risk factors that often occurs in TB patients. Currently, the prevalence rate of pulmonary TB continues to increase along with the increase in the prevalence rate of patients with Diabetes Mellitus. Hyperglycaemia disrupts the activity of *innate immunity* resulting in hyperactivity of *adaptive immunity*. This impacts on TB infection, as Th1 cells increase the release of IFN- $\gamma$  which has a dominant role in *delayed type hypersensitivity* (DTH) reactions. The presence of *Mycobacterium tuberculosis* in hyperglycaemia conditions will accelerate the process of granuloma formation. Based on this, it is suspected that lung tissue damage and cavities formation are easier to occur in uncontrolled Diabetes Mellitus patients (Dewi, 2019).

In contrast to the results of a study conducted by Meng Rui Lee, et.al (2017) in China who collected ORs from 4 studies, the authors found no evidence of a significant association between DM and the incidence of latent TB infection (pooled OR, 1.01; 95% CI, 0.78-1.31).

### 2. Risk Factors of Nutritional Status / BMI for Latent TB Infection

The nutritional status of respondents was based on the measurement of Body Mass Index. BMI in this study is categorised into 2, namely high risk and low risk. IMT status is categorised as high risk if the IMT status is *overweight* and categorised as low risk if the IMT status is normal.

Based on the results of univariate and bivariate analyses on nutritional status / BMI variables showed that out of 118 respondents, most were low risk in the control group (72.15%) and in the case group most were low risk (58.97%). This study found that body mass index is a risk factor that is not significant for the incidence of latent TB infection. Respondents whose BMI in the high risk category only increased the risk of 1.802 times experiencing TB Latent Infection compared to respondents whose BMI in the low risk category. with lower limit and upper limit (LL-UL) values including the value of 1.

BMI data for each respondent, both case and control groups, were obtained through secondary data from the Puskesmas Tuberculin Examination register.



Measurement of body weight and height was carried out prior to tuberculin injection in the patient's arm. However, the calculation of Body Mass Index was carried out by the researcher. From the results of data collection in the field, it was found that respondents in the case category and control category did not have differences in Body Mass Index, namely having a Normal BMI. This is because latent TB infection is a condition that does not cause clinical symptoms such as active TB which affects appetite, so it cannot reduce or increase body weight. Based on interviews regarding dietary arrangements, most respondents have a regular diet that meets the nutritional needs of the body so that the immune system can work properly to fight infections that cause symptoms.

The results of this study are in line with research conducted by Arfiana, Kumiati and Prayitno (2018) which states that TB infection increases energy needs to maintain normal body function so that there is an increase in energy use at rest or *Resting Energy Expenditure (REE)* This increase reaches 10-30% of the energy needs of normal people. So that there are people with TB who have normal body weight.

The results of different studies conducted by Haoran Zhang, et.al (2017) state that body mass index has been shown to be associated with the susceptibility of the host to several infections The strength of the relationship between positive IGRA and  $BMI \geq 28.0 \text{ kg/m}^2$  is statistically significant with an OR value: 1,52. Excess adiposity negatively impacts immune and defence function in obese individuals. In addition, the accumulation of adipose tissue might weaken pulmonary defence through metabolic disturbances. Therefore, a potential mechanism underlying the association of obesity and TB infection is that adipose tissue influences through various immune mediators. According to <sup>6</sup> Obesity induces an exaggerated immune response to mycobacterial challenge. Thus, *M. tuberculosis* clearance or pro-inflammatory response, which leads to the establishment of latent TB and halts disease progression <sup>6</sup>.

## 2. Risk Factors of BCG Vaccine History for Latent TB Infection.

BCG immunisation is an immunisation used to prevent severe, primary or mild TB disease. In this study, researchers conducted direct interviews and observations of respondents by looking at BCG scars on

the arms of respondents, as for respondents who did not have scars, it was considered that they had never received BCG immunisation so they were categorised as high-risk respondents. Conversely, if the respondent has a BCG Vaccine scar, it is considered to have been given BCG Immunisation and is considered a low risk respondent.

Based on the results of univariate and bivariate analysis on the BCG Vaccine history status variable, it shows that out of 118 respondents, most of them are low risk in the control group (74.68%) and high risk in the case group (69.23%) This study found that respondents with a history of BCG vaccine in the high risk category can increase the risk of 6.637 times experiencing Latent TB Infection compared to low risk category respondents.

This study is in line with research conducted by Chanpo Patimaporn, et.al (2020) in Northeast Thailand which showed that the absence of BCG scar was associated with latent TB infection (OR = 2.59, 95% CI: 1.50-4.47,  $p = 0.001$ ). BCG vaccine efficiently prevents miliary and meningeal TB and has preventive effectiveness against pulmonary TB in adults. The presence of BCG scarring is an important indicator and confirmation of TB vaccination. Poor immunity due to inadequate administration of Bacille Calmette-Guérin (BCG) vaccine is considered a greater risk for developing latent TB infection.

In principle immunological concepts, when the body receives BCG vaccination, phagocytosis by macrophages and dendritic cells initiates an immune response from the nonspecific immune system through the secretion of immunomodulatory components such as cytokines and chemokines. Our body's immune system responds to the administration of BCG vaccination, also supported by the World Health Organisation (WHO) which states that BCG is the only vaccine accepted for use in preventing TB infection.<sup>9</sup>

In contrast, Celso Belo and Saloshni Naidoo (2017) in Nampula Hospital, Mozambique, found that BCG vaccination showed a negative association with latent TB infection which was not significant (OR 0.66 [95% CI 0.26; 1.65]).<sup>5</sup>

## 3. Residential Density Risk Factors for Latent TB Infection

Occupancy density is the ratio of the number of occupants to the area of the house occupied by the



patient in units of square metres (m<sup>2</sup>), with a minimum requirement of 8 m<sup>2</sup> / patient. In this study, respondents were categorised as high risk if the house area was < 8 m<sup>2</sup> / person and low risk if  $\geq 8$  m<sup>2</sup> / person. The density of house occupancy was carried out by researchers by conducting direct observations and measuring the size of the house by comparing the number of people in the house, but the researchers also conducted roomisation, namely the room area compared to the number of people sleeping in the room every day.

Based on the results of univariate and bivariate analyses on the variable of house occupancy density, it shows that out of 118 respondents, most of them are low risk in the control group (79.75%) and high risk in the case group (58.97%). This study found that respondents with high-risk category residential density can increase the risk of 5.660 times experiencing Latent TB Infection compared to low-risk category respondents.

The results of the study are in line with Kadek Amika's research (2020) at Puskesmas Buleleng Bali, which showed a p value = 0.001 ( $p < 0.05$ ) and OR = 7.109 (95% CI 2.080 - 24.298) this shows statistically that there is a relationship between residential density and transmission of TB germs to household contacts at Puskesmas Buleleng III. The risk of 7.109 times greater for respondents with a dense residential density category contracting Lung Tuberculosis than respondents with a non-compact residential density category.

The density of bedroom occupancy of the floor area of a healthy house must be sufficient for the occupants in it, meaning that the floor area of the house must be adjusted to the number of occupants so as not to cause overload. This is unhealthy, because in addition to causing a lack of oxygen, if one family member has an infectious disease, it will easily spread to other family members. The optimum building area is if it can provide 2.5 x 3 m for each person (each family member).

The density of residential houses that do not meet the requirements with the habit of often closing windows can facilitate the spread of tuberculosis bacteria due to poor air circulation, besides that it can also reduce the intensity of house lighting sourced from direct sunlight which can kill bacteria that cause diseases, especially tuberculosis.<sup>10-12</sup>

In contrast to research conducted by Pesik (2015) on the relationship between residential density and TB transmission at Puskesmas Tumpaan, South Minahasa Regency, which states that there is no relationship between residential density and the incidence of Pulmonary Tuberculosis (Pesik, 2015).

## 2. Risk Factors of Home Ventilation on the Incidence of Latent TB Infection

Ventilation is the condition of a house that has sufficient air circulation in and out with a minimum ventilation area of 10% of the floor area. In this study, what is meant by ventilation area is the number of places where air exits or enters in the form of windows or angina holes that are often opened or rooms that have air conditioning are considered eligible as long as they are cleaned once every 6 months in the respondent's house. Researchers conducted direct interviews, observations and made direct measurements of the ventilation area using a meter and compared it with the floor area, Comparison of the number of people living in the house with the floor area in square metres, Minimum requirement of 10 square metres per person (Permanent vent area divided by the floor area of the house multiplied by 100%). High risk criteria is if < 10% of the floor area of the house and low risk if  $\geq 10\%$  of the floor area of the house (often opened or using air conditioning and air conditioning is routinely cleaned).

Based on the results of univariate and bivariate analysis on the variable Home ventilation showed that of the 118 respondents most were low risk in the control group (75.95%) and high risk in the case group (61.54%). This study found that respondents with high risk category home ventilation could increase the risk of 5.052 times experiencing Latent TB Infection compared to low risk category respondents.

This is in line with research conducted in the work area of the Liukang Tupabbiring Puskesmas, Pangkep Regency, which states that the ventilation area of the house ranges from 2.4-6.56 m<sup>2</sup> and the floor area of the house 35-72 m<sup>2</sup> is not eligible and will exacerbate the risk of developing TB 1.314 times in residents who have ventilation that does not meet the requirements compared to respondents who have ventilation health requirements.<sup>13</sup>

Rooms with unqualified ventilation area (<10% floor area) cause high humidity and temperature in the room



due to lack of air exchange from outside the house, giving TB bacteria the opportunity to survive in the room because of the nature of TB bacteria that can survive in a dark and humid room (Sahadewa et al., 2019). (Sahadewa *et al.*, 2019)..

Insufficient ventilation will cause an increase in room humidity due to the process of evaporation and absorption of fluids from the skin. High room humidity will be a good medium for the growth and proliferation of pathogenic bacteria including Lung TB germs. Lung TB bacteria will die at 100<sup>0</sup> C heating for 5-10 minutes, or at 60<sup>0</sup> C for 30 minutes. The ability of Lung TB bacteria to grow at a temperature of 35 C-37<sup>00</sup> C, does not grow at a temperature of 25<sup>0</sup> C or more than 40<sup>0</sup> C, and Lung TB bacteria will thrive in an environment with high humidity, because water makes up more than 80% of the volume of bacterial cells and is the best medium for the growth and survival of bacterial cells.<sup>15</sup>.

In contrast to research conducted by (Butiop, Kandou and Paladeng, 2015).. in Wori Village, showed that the results of statistical analysis using the logistic regression test on the variable of ventilation area with TB incidence obtained a value of  $p > 0.005$ . This means that there is no relationship between the variable of ventilation area and the transmission of TB germs.

### Conclusion

There are several risk factors for TB Latent Infection in Mamuju Tengah District, namely DM Disease Status, BCG Vaccine History, House Occupancy Density, and House Ventilation. Among these risk factors, BCG vaccine history is the most risky factor for TB Latent Infection. Increased logistical availability of Tuberculin testing in risk groups needs to be widespread to reach more Latent TB cases in Mamuju Tengah District.

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