

Socio-Economic and Demographic Determinants of Pulmonary Tuberculosis among Adults in Indonesia

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ABSTRACT

Tuberculosis remains a major public health challenge in Indonesia, with a substantial disease burden particularly affecting the productive-age population. Beyond biological susceptibility, socio-economic disparities are recognized as key contributors to the risk of pulmonary tuberculosis. However, comprehensive analyses using nationally representative data remain limited. This study aimed to examine the association between socio-economic determinants and the incidence of pulmonary tuberculosis among adults in Indonesia. An observational analytic study with a cross-sectional design was conducted using combined secondary data from the 2023 Indonesian Health Survey and the National Socio-Economic Survey, comprising a total of 174,062 respondents. Socio-economic variables included educational level, income, housing density, housing environmental quality, and access to health services, while age, sex, place of residence, and occupation were treated as confounding variables. Data analysis consisted of univariate procedures, bivariate tests using Chi-square and Mann-Whitney, and multivariate analysis using multiple logistic regression. The findings indicated that low educational level ($p < 0.001$; OR=1.8), low income ($p = 0.042$; OR=0.8), high housing density ($p = 0.009$; OR=1.4), male sex ($p < 0.001$; OR=1.8), urban residence ($p = 0.029$; OR=1.4), age ($p < 0.001$; OR=1.02), and occupation ($p = 0.009$) were significantly associated with pulmonary TB incidence. In conclusion, these results demonstrate that socio-economic and demographic factors play a substantial role in the occurrence of pulmonary tuberculosis in Indonesia. Strengthening TB control efforts through socio-economic improvement, enhanced educational attainment, and targeted promotive and preventive interventions for high-risk groups is essential to reduce disease transmission.

Keywords: tuberculosis; socio-economic factors; adult

INTRODUCTION

Tuberculosis (TB) remains one of the most persistent medical challenges at both global and national levels. An estimated 10.8 million TB cases occur worldwide, reflecting the continued magnitude of this infectious disease. In 2023, TB ranked as the second leading cause of mortality globally after COVID-19, with 1.1 million recorded deaths. These figures underscore that TB continues to pose a serious threat to global health [1]. The Southeast Asia region contributes approximately 45% of the global TB burden, with Indonesia occupying the second-highest position after India. According to the 2023 Report of the Indonesian Tuberculosis Control Program, an estimated 1,090,000 TB cases were identified, equivalent to 387 cases per 100,000 population, with mortality reaching 125,000 deaths. Although TB-related deaths declined by 7% compared with the previous year, the number of TB cases increased by approximately 3% from 2022, indicating that TB transmission in Indonesia remains active and continues to hinder national elimination efforts [2].

Pulmonary tuberculosis disproportionately affects individuals in the productive age group, particularly those aged 15–50 years. The Global TB Report 2022 highlights that the highest incidence occurs among individuals aged 25–34 years [3]. This age group represents a critical phase of social and economic productivity [4]. Consequently, the impact of TB extends beyond health outcomes, exerting substantial social and economic consequences on affected individuals [5]. On average, TB patients lose three to four months of work time, resulting in an annual income reduction of 20–30%, and in severe cases, the loss of a primary source of livelihood due to premature mortality. Moreover, TB patients frequently experience social stigma, discrimination, and social exclusion, further exacerbating their vulnerability and diminishing their overall well-being [6].

A growing body of evidence demonstrates that TB incidence is closely linked to socio-economic conditions. Individuals with low educational attainment, limited income, and residence in overcrowded, substandard, or unsanitary housing environments face a significantly higher risk of TB infection. Low levels of education and income may restrict access to health information, healthcare services, and preventive measures, thereby increasing susceptibility to TB. Previous studies have examined the relationship between socio-economic factors and TB incidence, although many have been limited to local settings with relatively small sample sizes. A study by Resmitia & Adam (2025) in Makassar showed that low educational attainment, informal employment, and low income were significantly associated with increased TB risk [7]. Similarly, research by Kusumaningrum et al. (2023) in Indonesia demonstrated that educational level, from junior high school to university low income, and inadequate housing conditions were positively associated with TB incidence [8].

Given these conditions, there is a need for research utilizing nationally representative data to strengthen scientific evidence regarding the role of socio-economic determinants in TB incidence in Indonesia. Therefore, this study aims to analyze the association between socio-economic factors, including educational level, income, housing density, and access to healthcare services and the occurrence of pulmonary tuberculosis in Indonesia using data from the 2023 Indonesian Health Survey (SKI) and the National Socio-Economic Survey (SUSENAS). The findings of this study are expected to provide robust scientific insights to support the development of more targeted and effective national TB control policies and strategies.

METHODS

This study was conducted using secondary data derived from two nationally representative surveys, namely the 2023 Indonesian Health Survey (*Survei Kesehatan Indonesia/SKI*) and the 2023 National Socio-Economic Survey (*Survei Sosial Ekonomi Nasional/SUSENAS*). Both surveys were implemented across all provinces and districts in Indonesia throughout the 2023 data collection period, ensuring broad geographic coverage and population-level representativeness. The research employed an observational analytic design with a cross-sectional and quantitative approach, allowing the assessment of associations between socio-economic characteristics and the occurrence of pulmonary tuberculosis at a single point in time.

The study population consisted of all individuals enumerated in the 2023 SKI and SUSENAS datasets. The research sample included respondents aged 15–50 years who had complete information on tuberculosis status and the socio-economic variables under investigation. Sample selection was carried out using purposive sampling based on predefined inclusion criteria, which required respondents to have complete

individual- and household-level data. Individuals with missing or incomplete information on key variables were excluded from the analysis. Based on these criteria, a total of 174,062 respondents were included in the final dataset.

The dependent variable in this study was the incidence of pulmonary tuberculosis, determined from respondents' reported TB diagnosis status in the SKI dataset. The independent variables consisted of several socio-economic indicators, including educational attainment, household income, housing density, housing environmental quality, and access to healthcare services. Confounding variables controlled in the analysis included age, sex, place of residence (urban or rural), and employment status. Each variable was measured according to the operational definitions established in the SKI and SUSENAS survey instruments, with socio-economic indicators derived from standardized national classifications.

Data analysis was conducted in several stages using statistical software. The initial stage involved univariate analysis to describe the distribution, frequency, and proportion of each study variable. Bivariate analysis was subsequently performed to examine the relationship between each independent variable and pulmonary TB incidence. Associations between categorical variables were assessed using the Chi-square test, while the relationship between the numerical variable (age) and the categorical dependent variable was analyzed using the Mann-Whitney test due to non-normal distribution. Multivariate analysis was then conducted using multiple logistic regression to identify the socio-economic factors most strongly associated with pulmonary tuberculosis after adjusting for confounders. The results were presented as odds ratios (OR) with 95% confidence intervals (CI) and corresponding p-values to determine statistical significance.

RESULTS

From a total of 174,062 respondents included in this study, the proportion of individuals diagnosed with pulmonary tuberculosis within the past year was very low, accounting for only 0.20%. Nearly half of the respondents had a low level of education (49.94%), while the majority belonged to the low-income group (65.28%). Regarding environmental conditions, most respondents lived in housing classified as inadequate (92.38%), and 9.21% resided in densely populated housing areas. Only 2.52% of respondents reported difficulty accessing healthcare services. The age distribution showed that most respondents were within the productive age range of 36–44 years. Female respondents constituted 55% of the sample, while 45% were male. More than half of the respondents lived in urban areas (54.88%), and 56.59% were employed. A detailed distribution of respondent characteristics is presented in Table 1.

The results in Table 1 indicate that although the prevalence of pulmonary tuberculosis is relatively low in the general population, TB remains a significant public health concern due to its complex risk factors and potential for transmission. The socio-economic profile of respondents shows that a substantial proportion belongs to vulnerable groups, particularly those with low education and low income. Environmental conditions also reveal that most respondents live in inadequate housing, which may contribute to increased susceptibility to infectious diseases. The age distribution reflects a predominance of individuals in the productive age group, which may increase exposure to TB due to higher mobility and social interaction. The sample is slightly dominated by females and urban residents, reflecting the demographic characteristics of the surveyed population.

The age distribution of respondents indicates that all individuals in the study were within the productive age range of 15–50 years, with relatively even proportions across age categories. The proportion of respondents increased notably in the 35–44-year age group, a period characterized by high levels of social and economic activity. This demographic pattern suggests a potentially greater likelihood of TB exposure due to more frequent and intensive social interactions. By sex, female respondents constituted a slightly larger proportion of the sample (55.00%) compared with males (45.00%). In terms of residential location, the majority of respondents resided in urban areas (54.88%), while 45.12% lived in rural settings. This distribution indicates that the study population is more representative of urban communities, which typically experience higher population density and distinct patterns of disease transmission compared with rural areas.

Regarding employment status, most respondents were employed (56.59%), followed by those who were not working (37.64%), and a smaller proportion who were still in school (32.77%). The predominance of employed individuals reflects the productive age profile of the sample, characterized by active economic participation. This condition may increase mobility and the frequency of social contact, making employment status relevant in the analysis of TB risk. Further details on the associations between socio-economic and demographic variables with pulmonary tuberculosis can be observed in Tables 2 and Table 3.

Table 1. Frequency distribution of respondent characteristics and pulmonary tuberculosis status

Variable	Frequency	Percentage
Tuberculosis		
No	173,711	99.80
Yes	351	0.20
Education		
High Education	87,129	50.06
Low Education	86,933	49.94
Income		
High Income	60,436	34.72
Low Income	113,626	65.28
Housing density		
Not Dense	158,035	90.79
Dense	16,027	9.21
Housing environmental quality		
Adequate	13,258	7.62
Inadequate	160,804	92.38
Access to healthcare services		
Easy	169,676	97.48
Difficult	4,386	2.52
Age		
15	5,094	2.93
16	4,888	2.81
17	4,444	2.55
18	3,815	2.19
19	3,476	2.00
20	3,286	1.89
21	2,999	1.72
22	3,123	1.79
23	3,527	2.03
24	3,082	1.77
25	3,224	1.85
26	3,654	2.10
27	3,809	2.19
28	4,186	2.40
29	4,190	2.41
30	4,599	2.64
31	4,933	2.83
32	4,975	2.86
33	5,483	3.15
34	5,379	3.09
35	5,806	3.34
36	5,816	3.34
37	5,694	3.27
38	6,218	3.61
39	5,984	3.44
40	6,296	3.62
41	6,360	3.65
42	5,669	3.26
43	6,333	3.64
44	5,739	3.30
45	5,442	3.13
46	5,422	3.11
47	5,489	3.15
48	5,556	3.19
49	4,901	2.82
50	5,107	2.93
Sex		
Female	96,734	55.00
Male	78,328	45.00
Place of residence		
Rural	78,542	45.12
Urban	96,520	54.88
Employment status		
Student	18,521	32.77
Unemployed	57,048	37.64
Employed	98,493	56.59

The Chi-Square results presented in Table 2 indicate that most socio-economic and demographic variables were significantly associated with the occurrence of pulmonary tuberculosis. Educational level demonstrated a strong association with TB incidence ($p < 0.001$), with respondents who had lower educational attainment showing a higher proportion of TB cases compared with those with higher education. Income was also significantly associated with pulmonary TB ($p = 0.042$), suggesting that economic conditions play an important role in TB occurrence. Housing density showed a significant association as well ($p = 0.019$), with respondents living in densely populated housing exhibiting a higher proportion of TB cases than those living in non-dense housing. From a demographic perspective, sex was significantly associated with TB incidence ($p < 0.001$), with males showing a higher proportion of TB cases than females. Place of residence also demonstrated a meaningful association ($p = 0.029$), with respondents living in urban areas experiencing higher TB incidence than those in rural areas. Employment status was likewise significantly associated with TB ($p = 0.009$), where employed respondents had a higher proportion of TB cases compared with those who were unemployed or still in school. In contrast, housing environmental quality ($p = 0.882$) and access to healthcare services ($p = 0.694$) did not show significant associations with pulmonary TB in this bivariate analysis.

The Mann-Whitney test results in Table 3 show that age was significantly associated with pulmonary tuberculosis ($p < 0.001$). The Z-value of -4.941 indicates a meaningful difference in age distribution between respondents with TB and those without TB. This finding suggests that TB incidence varies significantly across age groups, implying that age contributes to the risk of developing pulmonary TB. These results confirm that age is an important factor that should be considered in the analysis of TB occurrence and warrants inclusion in multivariate modeling.

The multiple logistic regression results in Table 4 further demonstrate that several socio-economic and demographic factors remained significantly associated with pulmonary tuberculosis after adjusting for confounders. Educational level showed a strong association ($p < 0.001$), with respondents of low educational attainment having 1.8 times higher odds of developing pulmonary TB compared with those with higher education (OR = 1.805; 95% CI: 1.44–2.26). Income also remained significant ($p = 0.042$), with low-income respondents having 0.8 times the odds of TB compared with high-income respondents (OR = 0.800; 95% CI: 0.64–0.99), indicating differential risk based on economic status.

Housing density demonstrated a clear and meaningful association with pulmonary tuberculosis ($p = 0.036$), indicating that the physical living environment remains a critical determinant of TB transmission. Respondents residing in densely populated housing had 1.4 times higher odds of developing TB compared with those living in non-dense housing (OR = 1.400; 95% CI: 1.02–1.91). This finding reinforces long-standing epidemiological evidence that overcrowded living conditions facilitate the spread of *Mycobacterium tuberculosis* through increased interpersonal contact, limited airflow, and inadequate ventilation. Dense housing environments often reflect broader structural disadvantages, such as poor housing quality, limited access to natural light, and suboptimal sanitation which collectively create ecological conditions conducive to airborne disease transmission. In the context of Indonesia's rapidly urbanizing regions, these findings highlight the importance of integrating housing and environmental health improvements into TB control strategies.

Age also remained a significant predictor of pulmonary TB ($p < 0.001$), with an odds ratio of 1.024. This means that each additional year of age increased the likelihood of TB by approximately 1.02 times (95% CI: 1.01–1.03). Although the incremental increase per year appears modest, the cumulative effect across the adult life course is substantial. This pattern aligns with the epidemiological profile of TB, which disproportionately affects individuals in the productive age group who experience higher mobility, greater social interaction, and increased exposure to diverse

Table 2. Chi-square test results for the association between independent variables and pulmonary tuberculosis

Variable	Tuberculosis	Not tuberculosis	p-value
Education			
High	86,996 (99.85%)	133 (0.15%)	< 0.001
Low	86,715 (99.75%)	218 (0.25%)	
Income			
High	60,296 (99.77%)	140 (0.23%)	0.042
Low	113,415 (99.81%)	211 (0.19%)	
Housing density			
Not dense	157,729 (99.81%)	306 (0.19%)	0.019
Dense	15,982 (99.72%)	45 (0.28%)	
Housing environmental quality			
Adequate	13,232 (99.80%)	26 (0.20%)	0.882
Inadequate	160,479 (99.80%)	325 (0.20%)	
Access to healthcare			
Easy	169,335 (99.80%)	341 (0.20%)	0.694
Difficult	4,376 (99.77%)	10 (0.23%)	
Sex			
Female	95,584 (99.84%)	150 (0.16%)	< 0.001
Male	78,127 (99.74%)	201 (0.26%)	
Place of residence			
Rural	78,404 (99.82%)	138 (0.18%)	0.029
Urban	95,307 (99.78%)	213 (0.22%)	
Employment status			
Student	18,498 (99.88%)	23 (0.12%)	0.009
Unemployed	56,943 (99.82%)	105 (0.18%)	
Employed	98,270 (99.77%)	223 (0.23%)	

Table 3. Mann-Whitney test results for age and pulmonary tuberculosis

Variable	Z	P-value
Age	-4.941	< 0.001

Table 4. Multiple logistic regression analysis of socio-economic and demographic factors associated with pulmonary tuberculosis

Variable	P-value	OR	95% CI
Education			
Low education	< 0.001	1.805	1.44–2.26
Income			
Low Income	0.042	0.800	0.64–0.99
Housing density			
Dense	0.036	1.400	1.02–1.91
Age	< 0.001	1.024	1.01–1.03
Sex			
Male	< 0.001	1.805	1.39–2.34
Place of residence			
Urban	0.001	1.465	1.17–1.82
Employment status			
Unemployed	0.135	1.481	0.88–2.47
Employed	0.341	1.287	0.76–2.16

environments. Age-related physiological changes, including gradual declines in immune function, may further heighten susceptibility to infection. These findings underscore the need for age-sensitive TB screening and prevention programs, particularly for adults in high-exposure occupations or densely populated communities.

Sex showed a strong and consistent association with TB incidence ($p < 0.001$). Male respondents had 1.8 times higher odds of developing pulmonary TB compared with females (OR = 1.805; 95% CI: 1.39–2.34). This sex disparity is well-documented in global TB literature and is often attributed to behavioral, occupational, and biological factors. Men are more likely to engage in outdoor work, experience higher levels of occupational exposure, and participate in social activities that increase contact frequency. Additionally, higher prevalence of smoking and alcohol consumption among men may impair lung function and weaken immune defenses, thereby increasing vulnerability to TB infection. These findings highlight the importance of gender-responsive TB interventions that address behavioral risk factors and occupational exposures.

Place of residence also emerged as a significant determinant of pulmonary TB ($p = 0.001$). Urban residents had 1.5 times higher odds of TB compared with rural residents (OR = 1.465; 95% CI: 1.17–1.82). This pattern reflects the complex interplay between urbanization, population density, environmental pollution, and lifestyle factors. Although urban areas typically offer better access to healthcare services, they also present conditions that facilitate TB transmission, including overcrowded settlements, high mobility, and greater social mixing. Urban air pollution may further compromise respiratory health, increasing susceptibility to infection. These findings emphasize the need for urban-focused TB control strategies that address environmental and social determinants alongside clinical interventions.

In contrast, employment status did not show a significant association with pulmonary TB after adjusting for other socio-economic and demographic variables. Neither unemployed respondents ($p = 0.135$; OR = 1.481; 95% CI: 0.88–2.47) nor employed respondents ($p = 0.341$; OR = 1.287; 95% CI: 0.76–2.16) exhibited independent effects on TB incidence. This suggests that employment, as a standalone variable, does not directly influence TB risk once other structural determinants—such as education, income, housing conditions, and place of residence—are taken into account. It is possible that the influence of employment operates indirectly through these other factors, or that the heterogeneity of job types dilutes any measurable effect. For example, some occupations may increase exposure risk, while others may not. The absence of a significant independent association in this study indicates that employment status alone is not a reliable predictor of TB risk in the Indonesian context.

Overall, these findings reinforce the multifactorial nature of TB transmission and highlight the importance of addressing structural and environmental determinants—particularly housing conditions, urban living environments, and gender-related vulnerabilities—within national TB control efforts.

DISCUSSION

The findings of this study demonstrate that socio-economic and demographic factors play a substantial role in the occurrence of pulmonary tuberculosis (TB) in Indonesia. After adjusting for confounding variables through multiple logistic regression analysis, several variables remained significantly associated with pulmonary TB, including educational level, income, housing density, age, sex, and place of residence. These results reinforce the understanding that pulmonary TB is not solely influenced by biomedical determinants but is also deeply embedded within broader social determinants of health.

Educational level emerged as one of the strongest predictors of pulmonary TB. Respondents with low educational attainment had 1.8 times higher risk of developing pulmonary TB compared with those with higher education. Empirically, this finding highlights the role of education in shaping individuals' knowledge, attitudes, and behaviors related to TB prevention and timely health-seeking practices [9]. This result is consistent with studies by Putu et al. (2024) and Darmin et al. (2020), both of which reported that low educational attainment increases the risk of pulmonary TB. From the perspective of the Social Determinants of Health framework, education is a structural determinant that influences individuals' capacity to access health information, recognize disease symptoms, and utilize healthcare services appropriately. Individuals with low education are more likely to experience delays in diagnosis and treatment, thereby increasing the risk of transmission and disease severity.

A similar conclusion was reported by Darmin et al. (2020), who identified a significant correlation between educational level and pulmonary TB incidence in the working area of the Inobonto Health Center, where respondents with low education were more likely to be infected [10]. This suggests that limited education contributes to higher vulnerability to TB due to restricted access to health information and medical services, resulting in delayed diagnosis and treatment. Conversely, higher educational attainment enhances individuals' health literacy, enabling them to adopt preventive behaviors and reduce the likelihood of TB infection [11].

Income also showed a significant association with pulmonary TB, although the direction of the association was relatively weak (OR < 1). This finding indicates that economic conditions continue to influence TB risk, although the magnitude of the effect may vary depending on contextual and population characteristics. This result aligns with Purwati et al. (2023), who found that low income increases the risk of pulmonary TB, but differs from Erpiano et al. (2023), who reported no significant association [12]. Such inconsistencies across studies can be explained through theories of social inequality, which posit that the impact of income on health is shaped by environmental conditions, social support, and access to healthcare. Individuals with low income are more likely to live in overcrowded environments, have poor housing quality, and face limitations in meeting nutritional and health needs, all of which indirectly increase susceptibility to TB [13].

Housing density was also significantly associated with pulmonary TB, with respondents living in densely populated housing having 1.4 times higher risk compared with those in non-dense housing. This finding reinforces TB transmission theory, which emphasizes the role of physical environment in facilitating disease spread. Densely populated homes often have poor ventilation, limited air circulation, and high frequency of interpersonal contact, creating ideal conditions for the transmission of *Mycobacterium tuberculosis* through airborne droplets. This result is consistent with Siregar et al. (2022), who identified a correlation between housing density and pulmonary TB incidence in the Tegal Sari Medan Denai Health Center area, where higher density increased the likelihood of transmission [14]. Similarly, Rahayu (2024) found that respondents living in rooms smaller than 8 m² with more than two occupants were at greater risk of TB compared with those living in larger, less crowded rooms [15]. These findings collectively indicate that overcrowded housing environments heighten TB transmission due to poor ventilation, reduced indoor air quality, and increased interpersonal contact [16].

Age was another significant factor, with each additional year of age increasing the risk of pulmonary TB by 1.02 times. This finding suggests that TB risk increases with age, particularly among individuals in the productive age group. This aligns with Arisandi & Farida Muhajir (2024), who reported that TB cases in Nglipar District were more common among individuals aged 36–59 years, a productive age range [17]. A similar pattern was observed by Lestari & Sufa (2024), who found that TB incidence in the Pringsewu Health Center area was significantly higher among productive-age individuals, with nearly fourfold greater risk compared with non-productive age groups [18]. These findings indicate that TB transmission is more likely among productive-age individuals due to higher mobility, frequent social interaction, and gradual decline in immune

function with age (Yosephine et al., 2021; [19]). Increased exposure to diverse social environments and occupational settings further contributes to heightened vulnerability [3].

Sex also showed a significant association with pulmonary TB, with males having 1.8 times higher risk compared with females. This finding is consistent with Rosyanti & Kusumaningtiar (2020), who identified a significant association between sex and pulmonary TB in the Cipayung Health Center, Depok, where male respondents were 3.633 times more likely to develop TB [20]. Similar findings were reported by Humayun et al. (2022) [21], who found that males had a 53% higher risk of TB compared with females. This increased risk among males may be attributed to greater involvement in outdoor activities, occupational exposure, and higher prevalence of smoking, all of which can impair immune function and increase susceptibility to TB infection [22].

Place of residence was also significantly associated with pulmonary TB, with urban residents having 1.4 times higher risk compared with rural residents. This finding is consistent with Septiani et al. (2025), who reported that TB cases were more prevalent in urban areas (26%) than in rural areas (23%). Although urban areas typically have better healthcare facilities, high population density, air pollution, and unhealthy lifestyle patterns contribute to increased TB risk [23]. Similar findings were reported by Rahayuningrum & Sulistyani (2024), who found that urban residents had 1.4 times higher risk of TB [24]. Urban environments often feature overcrowded settlements and suboptimal housing conditions, which facilitate bacterial transmission and increase TB incidence [25].

Although the Chi-Square analysis initially showed a significant association between employment status and pulmonary TB ($p = 0.009$), this association did not remain significant after adjusting for confounders in the logistic regression model. Both unemployed ($p = 0.135$) and employed respondents ($p = 0.341$) showed no independent association with TB. This finding aligns with Susilowati et al. (2023), who reported a significant association between employment and TB risk in the Tanjung Selor Health Center area [26], but differs from Dewi & Susilawati (2024), who found no significant association in Kupang City. Their study suggested that employment type does not directly influence TB risk because occupational environments do not necessarily facilitate bacterial growth or transmission [27]. However, certain occupations involving frequent public interaction, such as trading, may increase exposure to TB due to higher contact rates with potentially infected individuals [28].

Overall, these findings underscore that pulmonary TB in Indonesia results from a complex interplay of socio-economic, demographic, and environmental factors. Therefore, TB control efforts cannot rely solely on biomedical interventions but must also incorporate social strategies such as improving educational attainment, enhancing housing conditions, reducing residential overcrowding, and implementing targeted promotive and preventive programs for high-risk groups.

CONCLUSION

This study concludes that the occurrence of pulmonary tuberculosis in Indonesia is significantly influenced by a combination of socio-economic and demographic determinants. Educational level, income, housing density, place of residence, age, and sex were all identified as factors associated with increased TB risk. Individuals with low educational attainment, low income, crowded living conditions, male sex, and residence in urban areas were found to have a higher likelihood of developing pulmonary TB. These findings underscore that TB control efforts cannot rely solely on biomedical interventions but must also address broader social determinants of health. Strengthening socio-economic conditions, expanding access to education, and improving community living environments are essential strategies to reduce TB incidence and support the achievement of national TB elimination targets.

Ethical consideration, competing interest and source of funding

-This study obtained ethical approval from the Health Research Ethics Committee of Universitas Negeri Malang, under approval number 11.10.01/UN32.14.2.8/LT/2025, valid from 11 October 2025 to 11 October 2026. All data used in this research were anonymized and analyzed solely for scientific purposes, ensuring the protection of respondent confidentiality and adherence to ethical standards in health research.

-There is no conflict of interest related to this publication.

-Source of funding is authors.

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