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Factors Influencing Pulmonary TB Transmission Among Household Contacts of TB Cases: Systematic Review

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Abstract

Tuberculosis (TB) remains a major global health problem, with Indonesia ranked second worldwide in TB incidence, estimated at 1,090,000 cases and 125,000 deaths annually. Household contacts are at particularly high risk due to prolonged exposure, making this setting crucial for transmission control. This study applied a systematic literature review based on PRISMA 2020 guidelines. Eligible studies (2020–2025) included case–control, cohort, and cross-sectional designs conducted in Indonesia and comparable settings. Populations consisted of household contacts of pulmonary TB cases. Eight articles have been analyzed. Data collection methods varied, including interviews, diagnostic tests and structured questionnaires. Statistical analyses commonly used logistic regression, yielding odds ratios (OR), confidence intervals (CI), and p-values. Key risk factors included poor ventilation, room crowding, and prolonged daily contact (≥5 hours), Biological risks were age <5 years (OR 8.38, CI 95%), malnutrition (OR 8.88), diabetes mellitus, and HIV infection, Social determinants included low education, inadequate hygiene, and weak family support, Protective factors were good nutrition, BCG vaccination, health education, and strong social support. Pulmonary TB transmission among household contacts is multifactorial, influenced by environmental, biological, and social-behavioral determinants. Actionable implications include improving home ventilation, reducing overcrowding, strengthening contact tracing, and enhancing family-based health education.

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Introduction

Tuberculosis (TB) remains one of the leading global causes of morbidity and mortality from an infectious disease (Selvaraju et al., 2023). According to the World Health Organization's (WHO) 2024 report, which presents data for 2023, an estimated 10.6 million people fell ill with TB globally. The disease burden was distributed across 6.5 million men, 3.8 million women, and 1.3 million children. In the same year, TB was responsible for approximately 1.3 million deaths, a figure which includes 417,000 fatalities among people living with HIV (WHO, 2024). TB persists in all countries and age groups; however, it is both curable and preventable. India bears the highest burden, accounting for nearly 27% of global cases, with an estimated incidence of 2.8 million in 2022 (WHO, 2024; Mandal et al., 2023). Geographically, the WHO regions most affected are Southeast Asia (46%), Africa (23%), and the Western Pacific (18%), followed by the Eastern Mediterranean (8.1%), Europe (2.9%), and the Americas (2.9%) (WHO, 2024).

According to the latest WHO Global Tuberculosis Report 2024, which presents data for 2023, Indonesia remains the country with the second-highest TB burden globally. An estimated 1.13 million people fell ill with TB in Indonesia in 2023, resulting in approximately 311,000 deaths (WHO, 2024; Stop TB Partnership, 2024). These statistics underscore the urgency of enhancing TB prevention and treatment efforts across Indonesia (Ministry of Health, Republic of Indonesia, 2025).

Several measures have been implemented by the government to control pulmonary TB risk factors, including case detection and treatment. Passive intensive case detection is conducted through examinations of patients with pulmonary TB symptoms who visit healthcare facilities. Active case

detection is carried out through tracing and examining contacts by healthcare workers and health cadres, with mass screening especially targeting vulnerable and high-risk groups (Sulaiman et al., 2023).

Household contact is one of the environmental factors contributing to tuberculosis transmission (Ulyani et al., 2025). A history of living in the same household or having close contact with pulmonary TB patients can lead to exposure to Mycobacterium tuberculosis. Therefore, controlling M. tuberculosis transmission requires case detection and treatment of pulmonary TB patients to break the chain of infection. Interrupting M. tuberculosis transmission is essential to prevent suspected pulmonary TB cases and the emergence of new TB cases (Kristini & Hamidah, 2020).

Several systematic reviews have explored general risk factors for TB transmission. However, the dynamic nature of TB epidemiology, particularly in high-burden countries such as Indonesia, necessitates an updated synthesis of the most recent evidence (post-2020). This review specifically focuses on the household setting as the epicenter of transmission, aiming to consolidate findings from recent studies (2020–2025) that investigate the complex interplay between environmental, biological, and socio-behavioral factors within the Indonesian context and comparable settings. Therefore, this review aims to provide a comprehensive and up-to-date analysis that is crucial for designing targeted and effective household-based intervention strategies in the ongoing effort to eliminate TB.

Methods

This study employed a Systematic Literature Review (SLR) approach with a descriptive design to collect and analyze articles available on the internet. The literature analyzed was obtained from published databases. The articles used were those published between 2020 and 2025, using the keywords: pulmonary TB household contact and household pulmonary TB examination. Searches were conducted through Indonesian electronic databases such as Pubmed, Science Direct, Google Scholar and ResearchGate.

Data were analyzed using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Exclusion criteria included: qualitative research articles, articles that were not accessible in full text, and those categorized as systematic reviews, literature reviews, or meta-analyses. The literature search yielded 1,376 research articles. Based on the study objectives, seven articles were selected after going through various stages following the PRISMA 2020 framework.

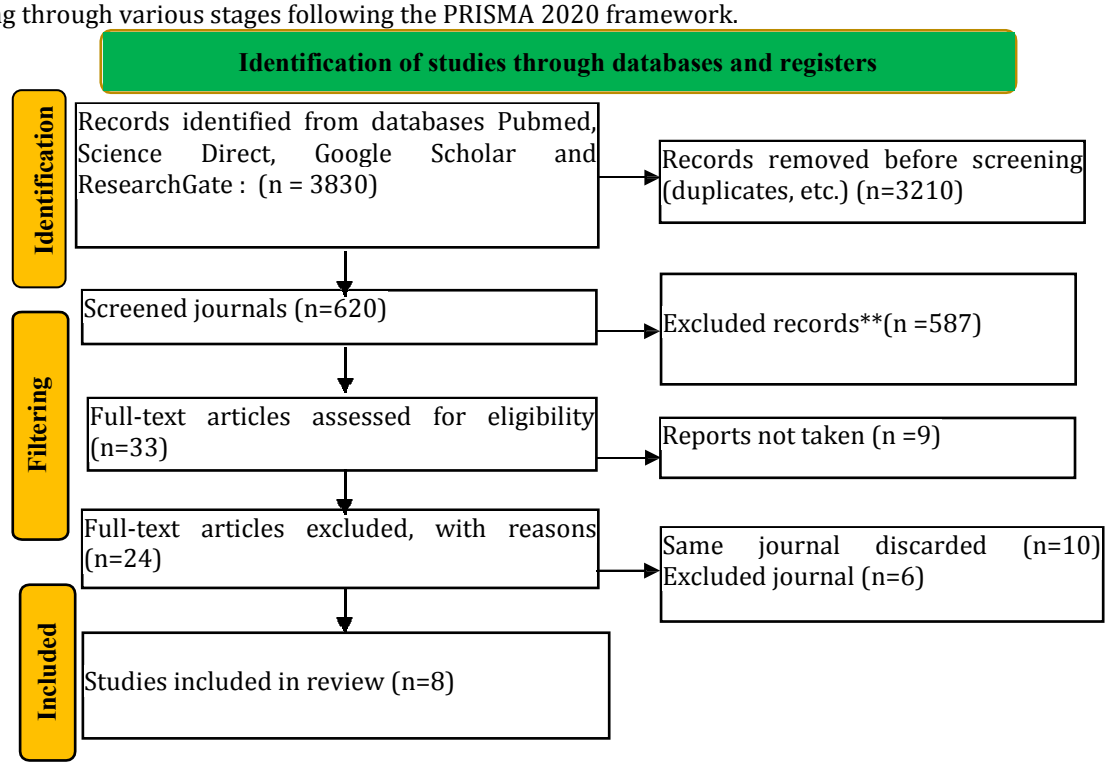

Figure 1. Systematic review flowchart: PRISMA

Results

A summary of the nine studies included in this review is presented in Table 1

Table 1. Systematic Review

No	Judul, Penulis dan Tahun	Variabel Penelitian	Methods	Populasi dan Sampel	Hasil Penelitian
1	Risk factors of tuberculosis in children with adult household tuberculosis contact (Setyoningrum et al., 2024)	Child's age (<5 years), nutritional status, BCG vaccination status, HIV	Cross-sectional (rekam medis 2010–2018)	367 children under 18 years old with household contact of adult TB cases.	Age <5 years (OR 8.38), severe malnutrition (OR 8.88), absence of BCG scar (OR 2.96), HIV positive (OR 6.72): risk factors for active TB among child contacts.
2	Latent tuberculosis infection in family members in household contact with active tuberculosis patients in Semarang City, Central Java, Indonesia (Karbito et al., 2022)	Daily contact ≥5 hours, room density (<8 m^2/2 people), type of occupation	Cross-sectional / contact tracing	138 family members from 112 active TB patients.	Prevalence of Latent Tuberculosis Infection 63.8%; main risk factors: laborer/fisher occupation (AOR 7.04), room density (AOR 5.33), contact duration ≥5 hours (AOR 4.70).
3	Assessment of Family Tuberculosis Contact Screening Practice and its Associated Factors Among Pulmonary Tuberculosis Positive Patients in South Wollo Zone, Amhara Region, Ethiopia (Jember et al., 2023)	Family support, service waiting time, health education, TB knowledge of the index patient	Cross-sectional; wawancara langsung, analisis multivariable logistic regression	403 smear-positive pulmonary TB patients (May–June 2020) in Amhara, Ethiopia.	Prevalence of family contact screening 55.3%. Significant factors: family support (AOR 2.21), waiting time <60 minutes (AOR 2.03), health education (AOR 1.86), good TB knowledge (AOR 2.76).
4	Factors affecting tuberculosis (TB) prevention behaviors among household contacts in Phitsanulok Province, northern Thailand: implications for TB prevention strategy plan (Wongchana & Songthap, 2024)	TB knowledge, risk perception (susceptibility), self-efficacy, outcome expectation, social support, smoking, transportation, BCG vaccination status, family relationship	Cross-sectional analitik, teori motivasi perlindungan (PMT) + dukungan sosial, multiregresi (PMC)	193 adult household contacts (aged 20–59 years) in Northern Thailand (May–July 2024).	Significant factors influencing TB preventive behavior: high self-efficacy, strong social support, non-smoking, having BCG knowledge, close relationship with patient (PMC).
5	The Yield of Active Tuberculosis	Age, nutritional status	Cohort cross-sectional	2,857 household TB	22.4% active TB; 45.7% Latent

No	Judul, Penulis dan Tahun	Variabel Penelitian	Methods	Populasi dan Sampel	Hasil Penelitian
	Disease and Latent Tuberculosis Infection in Tuberculosis Household Contacts Investigated Using Chest X-ray in Yogyakarta Province, Indonesia (Nababan et al., 2024)	(underweight), diabetes mellitus, urban residence, sleeping in the same house as the index case	(skrining CXR + TST/IGRA + Xpert MTB/RIF), analisis regresi logistik multivariat	contacts from Yogyakarta and Kulon Progo (June 2020–December 2022).	Tuberculosis Infection. Active TB factors: older age, underweight, diabetes, urban residence, sleeping in the same house. Latent Tuberculosis Infection factors: increasing age and male gender.
6	Determinan Sosial, Ketahanan Pangan, Praktik Hygiene, dan Kondisi Rumah Pasien TB Paru BTA (+) sebagai Faktor Risiko Penularan TB Riwayat Kontak Serumah (Sofiyani & Wijayanti, 2022)	Education, food security, hygiene practices (handwashing, sun-drying bedding), ventilation, type of wall, type of floor	Case–control; 74 sampel, analisis bivariat (Chi-Square) & multivariat regresi logistik	Household contacts of smear-positive pulmonary TB patients in specific regions; 74 case-control samples.	Significant risk variables: low education, poor food security, not sun-drying bedding, not opening windows, not washing hands, poor ventilation, and substandard wall/floor types collectively increasing risk by up to 85.2%.
7	Hubungan Keberadaan Kontak Serumah dan Perilaku Ibu terhadap Kejadian Tuberkulosis Anak (Rosmala Dewi et al., 2020)	Presence of household contact (intensity & closeness), maternal behavior (knowledge, BCG immunization)	Case–control; wawancara + kuesioner; analisis Chi-Square	Children in five community health centers in Bandar Lampung: 66 pediatric TB cases & 66 healthy controls (n = 132).	Keberadaan kontak Presence of household contact, intensity & closeness of contact, maternal knowledge, and BCG immunization status are significantly associated with TB incidence in children ($p < 0.05$).
8	Analisis Determinan Kejadian Tuberkulosis Resisten Obat: Data Wilayah Kerja Puskesmas Tilango Kabupaten Gorontalo (Hijrawaty, 2023)	Family history of TB, household contact with TB patients, housing density	Case–control, analisis bivariat & OR (logistik)	Population of pulmonary TB patients in the working area of Tilango Community Health Center, Gorontalo; case and control samples (exact number not specified).	Family history (OR = 5.469; $p < 0.001$), household contact (OR = 4.614; $p = 0.001$), and housing density (OR = 5.231; $p < 0.001$) are significant risk factors for pulmonary TB transmission.

Discussion

Physical Home Environment Factors

Five out of eight articles mentioned risk factors that can cause the occurrence of pulmonary TB transmission in household contacts with patients. The home environment is a major determinant in the transmission of pulmonary TB. Sofiyani & Wijayanti (2022) found that poor ventilation, substandard walls and floors, as well as behaviors such as not opening windows and not sun-drying bedding, increase the risk of transmission by up to 85.2%. This is consistent with the findings of Karbito et al. (2022) in Semarang, who reported that bedroom density of less than 8 m^2 for two people and daily contact of ≥5 hours were significant factors associated with the high prevalence of latent TB infection (63.8%). Research by Nababan et al. (2024) in Yogyakarta also reinforces this finding, showing that living in the same household and residing in urban areas with limited ventilation are associated with increased risk of both active and latent TB. Infectious disease epidemiology theory states that residential overcrowding increases the likelihood of inhaling *Mycobacterium tuberculosis* droplet nuclei in enclosed spaces, especially when air circulation is limited (Murray et al., 2021). Therefore, an unhealthy physical home environment is a key structural factor in the chain of pulmonary TB transmission. Environmental-based interventions such as improving housing quality and ventilation, educating about the dangers of smoking, and enhancing community nutritional status are crucial TB prevention measures (Handayani & Palino, 2025).

Penting untuk dipahami bahwa literatur review ini dilakukan terhadap artikel-artikel yang terpublikasi yang sebagaian besar berasal dari Indonesia. Dengan demikian faktor risiko yang terjadi kaitannya dengan penularan TB paru kontak serumah dengan penderita bisa saja berbeda dari satu daerah dengan daerah lainnya. Demikian pula tahun artikel Dimana penulis membatasi artikel yang direview Adalah 5 tahun terakhir (2020-2025), sehingga penulisan ini bisa terjadi bias dan mungkin menunjukkan hasil peneli

Biological Factors and Individual Health Status

Two out of the eight articles discussed the influence of biological factors and individual health status on pulmonary TB transmission among household contacts. Individual susceptibility also plays a significant role. Setyoningrum et al. (2024) showed that children under 5 years old with poor nutritional status, no BCG scar, and HIV-positive status have a higher risk of developing active TB (OR 6–9 times greater). Similarly, Nababan et al. (2024) found that being underweight and having diabetes mellitus increase the risk of active TB. This aligns with immunology theory, which emphasizes the role of nutrition and immunization in strengthening the body's resistance against *M. tuberculosis* infection (WHO, 2021). BCG vaccination has been proven to provide partial protection, especially in children, while good nutrition contributes to effective cellular immune function that suppresses TB bacilli multiplication (Lönnroth et al., 2020).

Socioeconomic and Family Behavioral Factors

Three out of the eight articles reviewed socioeconomic factors and family behavior related to pulmonary TB transmission among household contacts. Socioeconomic dimensions also play an important role. Hijrawaty (2023) in Gorontalo found that a family history of TB, residential overcrowding, and low socioeconomic status increase the risk of TB (OR 4–5 times). Rosmala Dewi et al. (2020) in Bandar Lampung emphasized that maternal knowledge and a child's immunization status are significantly associated with pediatric TB incidence. Nursia Aja et al. (2023) in Ternate also found that family knowledge and preventive practices reduce the risk of transmission. This is consistent with the Health Belief Model (HBM), which states that an individual's perception of susceptibility, perceived benefits of prevention, and social support influence disease prevention behavior (Rosenstock, 1974; Glanz et al., 2021). Family social support and health education have been proven to improve TB prevention behaviors, as also reported by Wongchana & Songthap (2024) in Thailand, where high self-efficacy, social support, and non-smoking status were positively associated with TB prevention behavior. Therefore, health education and family social support are crucial in breaking the chain of TB transmission within households. Family involvement in providing motivation, tangible assistance, and treatment-related information plays an important role in the successful management of pulmonary TB (Mongan & Fajar, 2017; Susilawaty et al., 2024).

From the above studies, it can be concluded that pulmonary TB transmission among household contacts is a multifactorial phenomenon. Home environmental factors (ventilation and density), biological factors (young age, nutritional status, immunization status, comorbidities), and socioeconomic and behavioral factors (knowledge, family support, health education) interact with each other. The

combination of these factors determines an individual's level of susceptibility and likelihood of contracting TB within the household.

Conclusion

Transmission of pulmonary TB among household contacts of TB patients is the result of a complex interaction between environmental, biological, socioeconomic, and behavioral factors. Overcrowded homes with poor ventilation, malnutrition, young age particularly children under five and comorbidities such as diabetes and HIV have been shown to increase vulnerability, while low knowledge levels, lack of family support, and minimal preventive practices further heighten the likelihood of transmission. Conversely, health education, social support, and good preventive behaviors can reduce the risk of infection. Consistent findings from various studies in Indonesia and abroad since 2020 underscore the need for a comprehensive household-based TB control approach that integrates improvements in environmental conditions, enhancement of nutritional status and immunization, and family empowerment through education and social support.

The authors suggest that efforts to minimize the transmission of pulmonary TB among household contacts of TB patients can be made by conducting periodic ventilation measurements and including other items that meet healthy house standards. Research can also be conducted using a case-control design, comparing patients living in households with poor ventilation against those in households with ventilation that meets healthy housing standards.

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