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THE ROLE OF ENVIRONMENTAL FACTORS IN THE INCIDENCE OF TUBERCULOSIS AND STUNTING IN CHILDREN

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ABSTRACT
Environmental factors play a crucial role in the incidence of tuberculosis (TB) and stunting in children. This study highlights the significant impact of environmental conditions, such as poor ventilation and inadequate sanitation, on the increased risk of both stunting and TB. Poor ventilation, uncontrolled humidity, and high occupancy density are directly linked to higher TB incidence, while inadequate sanitation has been shown to negatively affect child growth and increase the risk of stunting. Recent data indicates that children living in poor sanitation conditions are twice as likely to experience stunting, while those in poorly ventilated environments are at higher risk of contracting TB. To reduce the burden of both health issues, it is recommended to improve household ventilation, enhance sanitation conditions, and provide community-based health education. These interventions can help lower the prevalence of TB and stunting in children, particularly in resource-limited areas.

Keywords: environment; stunting; tuberculosis

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INTRODUCTION

Stunting is a physical growth disorder characterized by a slowed growth rate and is a consequence of nutritional imbalance. Stunting is based on the index of length-for-age (LA/A) or height-for-age (HA/A), with a threshold (z-score) of less than -2 standard deviations (SD) (Harmiardillah, 2023).Tuberculosis, commonly known as pulmonary TB, is a disease that has been around for a long time and remains one of the major health issues to this day. Pulmonary tuberculosis is a contagious disease caused by the bacterium Mycobacterium tuberculosis, which can affect various organs but primarily targets the lungs. Individuals with pulmonary tuberculosis are at risk of transmitting the disease to those around them, especially to those who have close contact with the patient. A person with pulmonary tuberculosis can potentially infect 10-15 people per year, and the transmission depends on the amount of bacteria released from the lungs(Salsabila Deliananda et al., 2022).

The progression of tuberculosis (TB) is influenced by two risk factors: internal risk factors and external risk factors. Internal risk factors contribute to the development of the infection into active TB disease, while external risk factors play a role in the exposure that leads to the infection(Wijaya et al., 2021).The number of TB cases in Bandung City is 10,003. The high number of pulmonary TB cases is due to a lack of public awareness about how to address tuberculosis, resulting in many people still contracting pulmonary TB, and the number of cases continues to increase each year. A person with TB and a positive sputum smear (BTA) with a high degree of positivity has the potential to spread the disease. Every one positive BTA case can transmit TB to 10-15 other individuals, so close contacts, such as family members living in the same household, are twice as likely to be at risk compared to casual contacts (those not living together)(Sutriyawan et al., 2022).

The physical condition of a house that does not meet proper standards can have a negative impact on its inhabitants. This condition is related to the transmission of diseases such as pulmonary tuberculosis (TB), which is caused by the bacterium Mycobacterium tuberculosis. One study found a significant relationship between the physical environment and the presence of Mycobacterium tuberculosis in the indoor air of gathering spaces in the respondents' homes. The analysis showed that factors such as temperature, humidity, and lighting were significantly associated with the presence of the bacteria(Afrina et al., 2023).The variability in research findings related to physical environmental factors and their varying levels of influence in different studies highlights the need for further investigation. The purpose of this study is to summarize and identify each physical environmental factor within specific contexts and its impact on tuberculosis (TB) in developing countries. Additionally, the study aims to compare and analyze the causes of these factors in developing nations. This research is expected to contribute to addressing the issue of tuberculosis, particularly in developing countries, which remain the largest contributors to TB cases worldwide, according to the World Health Organization (WHO). By providing a comprehensive understanding of the environmental factors influencing TB, the findings of this study could support more effective interventions in tackling this public health challenge.

METHOD

This study utilized a systematic review method guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol. The study focused on exploring the relationship between physical environmental factors indoors as independent variables and the incidence of pulmonary tuberculosis as the dependent variable. Therefore, the journals selected for review were those specifically addressing the relationship between these two aspects. The systematic review process included the identification, screening, and inclusion of studies that met the established criteria. By adhering to the PRISMA protocol, the study ensured a structured approach to collecting and analyzing data, providing a comprehensive understanding of how environmental factors influence the incidence of tuberculosis and stunting in children. This study employs a literature review method. Journal searches were conducted using academic databases such as Google Scholar and PubMed, focusing on publications from 2019 to 2024 in both Indonesian and English languages.

Table 1.
The inclusion criteria for this study are:

Inclusion Criteria	Exclusion Criteria
Population: Children aged 0-18 years exposed to environmental factors associated with tuberculosis (TB) and stunting.	Population: Studies not focusing on children or those primarily involving adults as subjects.
Study Type: Quantitative or qualitative studies examining the relationship between environmental factors (sanitation, ventilation, access to clean water, hygiene, etc.) and the incidence of TB and stunting.	Study Type: Studies focusing solely on medical or clinical aspects without considering environmental factors in the context of TB and stunting.
Study Location: Research conducted in areas with high prevalence of TB and stunting, both in developing and developed countries with relevant data.	Study Location: Studies conducted in areas with very low prevalence of TB and stunting or irrelevant contexts to the research focus.
Environmental Factors: Research that includes specific environmental factors such as sanitation, household ventilation, access to clean water, hygiene, and housing conditions.	Environmental Factors: Studies not examining environmental factors or those focusing only on individual factors (e.g., genetics, diet) without considering social and physical environmental factors.
Publication Year: Articles published within the last 10 years to ensure the data and findings are recent.	Publication Year: Studies published more than 10 years ago, to ensure relevance and currency of the data.
Language: Articles published in English or Indonesian.	Language: Articles written in a language not understood by the research team (e.g., languages that cannot be easily translated).

RESULT

Based on the literature review, 21 articles were found that are related to environmental factors, tuberculosis (TB) in children, and stunting. The detailed contents of these articles are presented in Figure 1 below. The article selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which included the following stages: 1) Identification: Collecting relevant articles through database searches; 2) Screening: Reviewing titles and abstracts to eliminate duplicates and articles that did not meet the criteria; 3) Eligibility: Evaluating articles based on inclusion and exclusion criteria; 4) Inclusion: Including articles that met the criteria for further analysis.

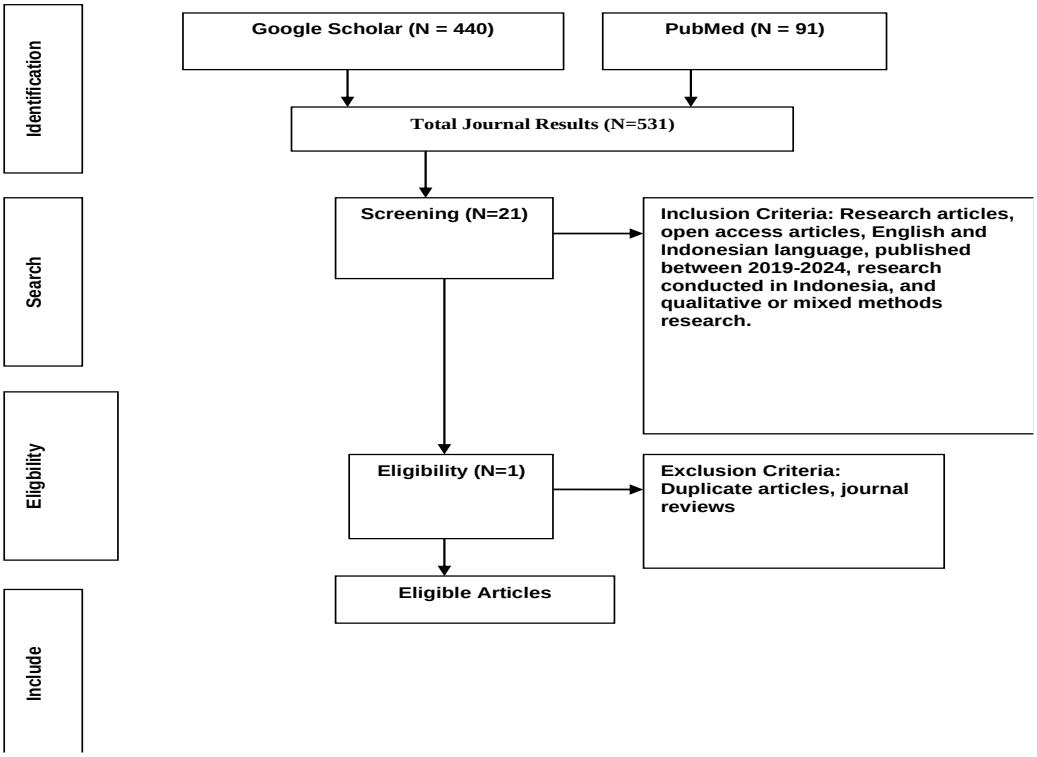

Figure 1. Stages of Article Search and Selection Leading to Reviewed Articles

DISCUSSION

This discussion synthesizes findings from multiple studies, highlighting environmental and nutritional factors associated with tuberculosis (TB) and stunting, while critically evaluating their contributions, limitations, and implications for public health interventions. To improve clarity, findings are organized into sub-themes: Ventilation and TB Risk, Sanitation and Stunting, Nutritional Status and TB Incidence, and Contact and TB Transmission.

Ventilation and TB Risk

Environmental factors, especially poor ventilation, were consistently identified as significant contributors to TB incidence. Afrina et al. (2023) highlighted ventilation area, humidity, and lighting as critical variables, while Prihartono et al. emphasized the role of housing characteristics such as occupancy density and wall type. These findings are supported by Indri Yosua et al., who found a strong correlation between poor ventilation and TB incidence across six reviewed journals.

Strengths:

1) These studies use robust data sources, including Riskesdas and meta-analyses, ensuring broad applicability.
2) The use of standardized criteria for housing environments enhances the validity of their conclusions.

Limitations:
1) Most studies rely on observational designs, which may be confounded by unmeasured socioeconomic variables.
2) Ventilation measurements often lack detailed specifications, reducing comparability across studies.

Gaps:
Future research should explore interventions to improve ventilation in resource-limited settings and evaluate their effectiveness in reducing TB transmission.

Sanitation and Stunting

Stunting in children is another critical public health issue closely linked to environmental factors such as sanitation. Ali Mashar et al. identified basic sanitation as a risk factor for stunting, while Oktavianisya et al. confirmed that environmental conditions, including inadequate sanitation, influenced child growth. Harmiardillah (2023) further emphasized the importance of health education in improving sanitation practices.

Strengths:
1) Studies leverage diverse methodologies, such as community service activities and case-control designs, to address sanitation-related stunting.
2) Strong emphasis on community-based interventions provides actionable insights.

Limitations:
1) Findings are limited by reliance on self-reported data for sanitation practices, which may introduce bias.
2) Interventions were often short-term, limiting understanding of sustained impacts.

Gaps:
Longitudinal studies are needed to evaluate the long-term impact of sanitation improvements on stunting prevention.

Nutritional Status and TB Incidence

Nutritional status, including malnutrition and stunting, emerged as a dominant risk factor for TB. Wijaya et al. (2021) and Sutriyawan et al. (2022) both noted that malnourished children had higher TB risk. Dhanny & Sefriantina (2022) also linked low protein and energy intake to increased TB susceptibility. These findings are echoed in Rakhmawati et al. (2023), where stunted toddlers showed higher TB prevalence.

Strengths:
1) The consistent association between malnutrition and TB across studies underscores its validity.
2) Meta-analyses, such as those conducted by Salsabila Delianandа et al., strengthen evidence by aggregating diverse datasets.

Limitations:
1) Nutritional interventions are rarely assessed in the context of TB prevention, leaving a critical gap.
2) Few studies account for genetic predispositions that may confound the malnutrition-TB relationship.

Gaps:
Future research should focus on evaluating integrated nutrition and TB prevention programs, particularly in high-risk regions.

Contact and TB Transmission

Contact history with TB patients remains the most significant predictor of TB transmission, as highlighted by Devi et al. (2020) and Afrina et al. (2023). Meta-analyses by Irma et al. (2023)

quantified this risk, showing individuals with a contact history are nearly five times more likely to contract TB.

Strengths:

1) Rigorous statistical methods, including logistic regression and random effects modeling, enhance reliability.
2) Studies account for multiple confounders, such as age and socioeconomic status.

Limitations:

1) Studies rarely differentiate between contact intensity and proximity, which are critical for transmission risk.
2) Most data are cross-sectional, precluding causal inferences.

Gaps:

Prospective studies should focus on quantifying transmission dynamics within households and communities, considering contact patterns and duration.The reviewed studies employ diverse methodologies, including case-control studies, literature reviews, and meta-analyses. However, most rely on observational designs, which, while valuable for identifying associations, are less effective in establishing causality. Variations in definitions, such as stunting thresholds and environmental measurements, pose challenges for cross-study comparisons. To address these issues, future research should standardize metrics and adopt experimental designs where feasible. Additionally, integrating qualitative methods can provide deeper insights into contextual factors influencing TB and stunting. Findings emphasize the need for multi-faceted interventions that address environmental, nutritional, and behavioral determinants of TB and stunting. Policies should prioritize:

1) Improving housing conditions and ventilation in high-density areas.
2) Scaling up nutritional support programs for malnourished children.
3) Enhancing public health education on sanitation and TB prevention.
4) Strengthening contact tracing and targeted screening for high-risk populations.

By addressing these factors holistically, public health initiatives can significantly reduce the burden of TB and stunting, particularly in vulnerable communities.

CONCLUSION

Overall, various studies demonstrate that environmental factors such as sanitation, access to clean water, toilet conditions, and hygiene practices are significantly associated with the incidence of stunting in children. These factors also contribute to the occurrence of tuberculosis in toddlers. Therefore, improving household ventilation, sanitation facilities, and promoting community hygiene education can significantly reduce the incidence of both TB and stunting in children

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