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Original Article

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Associations of indoor smoking and household environmental conditions with tuberculosis occurrence in south sorong, indonesia

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ABSTRACT

Introduction: Tuberculosis remains a major public health concern, particularly in communities where household behaviors and environmental conditions may facilitate transmission. Indoor smoking can impair respiratory defenses and reduce indoor air quality, while inappropriate temperature and humidity may create household environments that are less favorable for respiratory health. This study examined the associations of indoor smoking, household temperature, and humidity with tuberculosis occurrence in South Sorong, Indonesia.

Research Methodology: A quantitative observational analytic study with a cross-sectional design was conducted among 79 respondents in the working area of Fkour Public Health Center, South Sorong Regency. Data were collected using questionnaires, a tuberculosis screening form, and direct measurements of indoor temperature and humidity using a thermohygrometer. Descriptive and bivariate analyses were performed using Chi-square-based tests with a significance level of 0.05.

Results: Tuberculosis was identified in 17 of 79 respondents (21.5%). TB occurred in 65.2% of respondents with poor indoor smoking practices compared with 3.6% among those with good practices. TB was also identified in 57.7% of respondents living in houses with non-compliant temperatures compared with 3.8% in compliant houses, and in 52.2% of respondents living in houses with non-compliant humidity compared with 8.9% in compliant houses. Indoor smoking, temperature, and humidity were significantly associated with tuberculosis occurrence (all $p<0.001$).

Conclusion: Indoor smoking and unfavorable household environmental conditions were significantly associated with tuberculosis occurrence. Strengthening smoke-free home policies, household environmental monitoring, contact investigation, and timely diagnostic follow-up may support community-based tuberculosis prevention and control.

Keywords: environmental health; humidity; smoking; temperature; tuberculosis

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INTRODUCTION

Tuberculosis (TB) remains a major public health challenge because its transmission is shaped not only by exposure to Mycobacterium tuberculosis but also by the interaction between individual behavior and the physical environment in which people live. In 2024, more than 10 million new TB cases were estimated globally, with Southeast Asia continuing to carry a substantial share of the burden. Indonesia remains one of the countries with the highest TB burden worldwide, with more than one million estimated cases annually and persistent mortality despite ongoing national control efforts[1,2]. These figures indicate that case detection and treatment alone are insufficient to achieve the national target of TB elimination by 2030. Prevention strategies must also address modifiable household exposures that may increase susceptibility to infection or facilitate transmission, particularly in areas where environmental health conditions and access to health services remain uneven.

Household conditions are particularly relevant because TB is transmitted through airborne particles released by individuals with active pulmonary disease. The likelihood of exposure increases when infectious particles accumulate in enclosed spaces with inadequate air exchange. In this context, indoor smoking represents a potentially important behavioral exposure[3,4]. Tobacco smoke contains thousands of chemical compounds that can deteriorate indoor air quality and impair respiratory defense mechanisms. Repeated exposure may disrupt mucociliary clearance, reduce macrophage activity, and weaken local immune responses in the respiratory tract, thereby increasing vulnerability to pulmonary infection. The problem extends beyond active smokers because household members may also be exposed involuntarily to second-hand smoke[5,6]. The manuscript emphasizes that smoking inside the home is inconsistent with healthy household behavior and may be particularly problematic in households where TB exposure already exists.

Evidence concerning smoking and TB has generally supported an adverse association, yet the household context deserves closer consideration. Prior studies cited in the manuscript indicate that individuals who smoke or live with family members who smoke may experience a higher occurrence of TB than those living in smoke-free environments[7,8]. However, smoking exposure rarely occurs independently of environmental conditions. Houses with limited ventilation, poor air circulation, and persistent tobacco smoke may allow particulate matter and other pollutants to remain suspended indoors for prolonged periods. Such conditions can produce a combined behavioral and environmental exposure that may be more relevant to community-level TB prevention than smoking status alone[9,10]. This perspective shifts the focus from an exclusively individual risk framework toward the household as an important unit of intervention.

Temperature and humidity are also important components of the indoor environment. Healthy housing standards referenced in the manuscript indicate an indoor temperature range of approximately 18–30°C and relative humidity of 40–60%. Departures from these ranges may reflect inadequate ventilation, insufficient sunlight, crowding, or broader housing deficiencies. High humidity can contribute to dampness and poor indoor air quality, while inappropriate temperature may influence the persistence of microorganisms and the comfort and respiratory health of occupants. Several studies summarized in the manuscript have reported significant relationships between physical housing conditions including temperature, humidity, ventilation, lighting, and residential density and pulmonary TB occurrence. Nevertheless, these findings are not completely uniform across settings, suggesting that the

contribution of individual environmental factors may vary according to local housing structures, climate, behavior, and socioeconomic circumstances.

This variability is particularly relevant in remote and resource-constrained settings such as South Sorong Regency, Southwest Papua, where geographical dispersion, unequal access to health services, socioeconomic differences, and substandard household environments may complicate TB control. Preliminary observations in the Fkour Public Health Center area identified TB cases alongside indoor smoking and household temperature and humidity conditions that did not consistently meet environmental health standards. Despite evidence linking smoking and housing conditions with pulmonary TB, context-specific evidence from South Sorong remains limited. Few local studies have examined indoor smoking together with objectively measured household temperature and humidity within a single analytic framework. This gap is important because TB prevention strategies in remote communities need to address modifiable household conditions that reflect the local environment. The novelty of this study lies in its integrated assessment of indoor smoking and directly measured household environmental conditions in an underrepresented eastern Indonesian setting. Temperature and humidity were measured using a thermohygrometer, while smoking practices and TB status were assessed through structured data collection and screening. This approach provides locally relevant evidence for household-based interventions, including smoke-free homes, environmental monitoring, contact investigation, and diagnostic follow-up. Accordingly, this study aimed to examine the associations of indoor smoking practices, household temperature, and humidity with tuberculosis occurrence in the working area of Fkour Public Health Center, South Sorong Regency, Indonesia.

MATERIALS AND METHODS

Study Design

This study employed a quantitative observational analytic design with a cross-sectional approach. The design was selected to examine associations between household behavioral and environmental exposures and tuberculosis status at a single period of observation. The independent variables were indoor smoking practices, household temperature, and indoor humidity, while tuberculosis status was treated as the dependent variable. Because exposure and outcome data were assessed within the same study period, the analysis was intended to identify statistical associations rather than establish temporal or causal relationships.

Setting and Participants

The study was conducted in July 2026 in the working area of Fkour Public Health Center, South Sorong Regency, Southwest Papua, Indonesia. Data collection covered four villages within the health-center catchment area: Wandun, Pasir Putih, Welek, and Bemus. The source population consisted of 355 patients recorded as having visited health services between February and May 2026 in these four villages. A total of 79 participants were included. Participants were selected using cluster random sampling, with the four villages serving as the sampling clusters. The sample was proportionally distributed across Wandun (n=19), Pasir Putih (n=16), Welek (n=21), and Bemus (n=23). Sample size was determined from the source population of 355 patients using the Slovin formula with a 10% margin of error, yielding a final sample of 79 participants.

The source manuscript does not explicitly report prespecified inclusion and exclusion criteria. Accordingly, such criteria were not retrospectively constructed for this report. For reporting in an international journal, the eligibility criteria should be added from the original

research protocol or field documentation if available.

Variables and Measurement

The primary outcome was tuberculosis status. In the original study, this variable was classified as TB or non-TB using a tuberculosis screening form. Participants classified as TB were those identified as having tuberculosis based on the study screening procedure, whereas participants who did not meet the screening criteria were categorized as non-TB. Because the manuscript describes the outcome primarily in terms of screening rather than bacteriological or molecular confirmation, the findings should be interpreted as screening-based TB status unless diagnostic confirmation can be documented. Indoor smoking was defined as smoking inside the household by either the respondent or another household member. It was assessed using a questionnaire and observational checklist and categorized as good when no smoking occurred inside the house and poor when the respondent or another household member smoked indoors.

Household temperature was measured in the room where household members commonly gathered using a thermohygrometer. Based on the environmental health criteria adopted in the study from Indonesian Ministry of Health Regulation No. 2 of 2023, temperature was categorized as meeting the standard when it ranged from 18°C to 30°C and as not meeting the standard when it fell outside this range. Indoor relative humidity was measured in the same household environment using a thermohygrometer. Humidity between 40% and 60% was classified as meeting the environmental health standard, whereas values outside this range were categorized as not meeting the standard.

Primary data were obtained directly from participants using questionnaires, observational forms, TB screening, and household environmental measurements. Secondary information was obtained from scientific literature, textbooks, websites, and the profile of Fkour Public Health Center. The study instruments included questionnaires, observational forms, a thermohygrometer, documentation equipment, and supporting field materials. The source manuscript does not report formal questionnaire validity testing, reliability coefficients, thermohygrometer calibration procedures, or inter-observer reliability. These parameters should therefore not be claimed. If instrument validation, pilot testing, or calibration was conducted during the original study, the corresponding procedures and results should be inserted before journal submission.

Data Collection and Quality Control

Data collection was conducted directly in the four selected villages. Information on indoor smoking practices was obtained using the structured questionnaire and observational form, while indoor temperature and relative humidity were measured objectively using a thermohygrometer. Tuberculosis status was determined using the study TB screening instrument. This combination of participant-reported and direct environmental measurements was used to characterize both behavioral and household environmental exposures.

Data quality management included checking completed forms for completeness, clarity, internal consistency, and accuracy before data entry. Responses were coded according to predefined variable categories, after which the coded data were entered into a computerized database for statistical analysis. These editing, coding, and data-entry procedures constituted the data-management quality checks documented in the manuscript.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26.0. Descriptive analysis was performed to summarize participant characteristics and the distributions of indoor smoking

practices, household temperature, humidity, and tuberculosis status. Categorical variables were presented as frequencies and percentages. Bivariate analyses were conducted to examine associations between each independent variable and tuberculosis status. The manuscript specifies the Chi-square framework; however, the reported results show that Fisher's exact test was used for indoor smoking and humidity where appropriate, while a continuity-corrected Chi-square test was applied to household temperature. Statistical significance was defined as a two-sided p value <0.05. The reported analyses identified significant associations between indoor smoking, household temperature, humidity, and tuberculosis status.

No multivariable analysis was reported in the original manuscript. Consequently, adjusted odds ratios, confidence intervals, and claims of independent predictors should not be added retrospectively without reanalysis of the original dataset. Given the binary outcome, multivariable logistic regression would be methodologically appropriate if the raw dataset remains available, but such an analysis would represent an additional analysis beyond the current manuscript rather than a description of the procedures already performed.

Ethical Approval

The submitted manuscript does not provide the name of a research ethics committee, an ethical approval number, or sufficient details regarding written informed consent. These details cannot be reconstructed reliably from the available document. Before submission to an international peer-reviewed journal, this section should be completed using the original ethical approval documentation and participant-consent procedures.

RESULTS

Respondent Characteristics

A total of 79 respondents were included in the analysis. Most participants were aged 31–35 years (67.1%), were female (60.8%), and were housewives (57.0%). Senior high school was the most common educational attainment (34.2%), followed by junior high school (27.8%) and primary school (25.3%). Regarding the main study variables, 29.1% of respondents were exposed to poor indoor smoking practices, 32.9% lived in houses with temperatures outside the recommended range, and 29.1% lived in houses with non-compliant humidity. Tuberculosis was identified in 17 respondents (21.5%). These distributions were verified against the individual-level master table contained in the manuscript.

Table 1. Characteristics of study participants (N = 79)

Characteristics	Category	n	%
Age	16–25 years	3	3.8
	26–30 years	23	29.1
	31–35 years	53	67.1
Sex	Male	31	39.2
	Female	48	60.8
Education	No formal schooling	6	7.6
	Primary school	20	25.3
	Junior high school	22	27.8
	Senior high school	27	34.2
	Higher education	4	5.1
Occupation	Civil servant	5	6.3
	Housewife	45	57.0

	Farmer	29	36.7
Indoor smoking practice	Good/no indoor smoking	56	70.9
	Poor/indoor smoking present	23	29.1
Household temperature	Meets standard	53	67.1
	Does not meet standard	26	32.9
Household humidity	Meets standard	56	70.9
	Does not meet standard	23	29.1
Tuberculosis status	TB	17	21.5
	Non-TB	62	78.5

The coding scheme in the master table defined poor indoor smoking practice as category 2, non-compliant temperature as category 2, non-compliant humidity as category 2, and TB as category 1.

Bivariate analysis demonstrated substantial differences in TB occurrence across all three household exposures. Among respondents with poor indoor smoking practices, 15 of 23 (65.2%) had TB, compared with only 2 of 56 (3.6%) respondents in smoke-free households. This corresponded to a crude odds ratio (OR) of 50.63 (95% CI: 9.71–264.06; p<0.001). The original contingency table and Fisher's exact test confirm the strong association between indoor smoking and TB occurrence. Similarly, TB occurred in 15 of 26 respondents (57.7%) living in houses with temperatures outside the recommended range compared with 2 of 53 (3.8%) respondents living in houses meeting the temperature standard. The crude OR was 34.77 (95% CI: 6.93–174.47; p<0.001). For humidity, TB occurred in 12 of 23 respondents (52.2%) living in houses with non-compliant humidity compared with 5 of 56 (8.9%) respondents in compliant houses, corresponding to a crude OR of 11.13 (95% CI: 3.25–38.07; p<0.001). The manuscript reports significant associations for both temperature and humidity.

Table 2. Bivariate associations between household factors and tuberculosis occurrence

Exposure	TB n/N (%)	Non-TB n/N (%)	Crude OR	95% CI	p-value
Indoor smoking					
Good/no indoor smoking	2/56 (3.6)	54/56 (96.4)	1.00	Reference	—
Poor/indoor smoking present	15/23 (65.2)	8/23 (34.8)	50.63	9.71–264.06	<0.001
Household temperature					
Meets standard	2/53 (3.8)	51/53 (96.2)	1.00	Reference	—
Does not meet standard	15/26 (57.7)	11/26 (42.3)	34.77	6.93–174.47	<0.001
Household humidity					
Meets standard	5/56 (8.9)	51/56 (91.1)	1.00	Reference	—
Does not meet standard	12/23 (52.2)	11/23 (47.8)	11.13	3.25–38.07	<0.001

OR = odds ratio; CI = confidence interval. Crude ORs and 95% CIs were calculated from the 2×2 frequency tables reported in the manuscript. Fisher's exact test was used for indoor smoking and humidity, while the manuscript applied a continuity-corrected Chi-square test for temperature.

The findings indicate that tuberculosis occurrence in this population was not distributed randomly across households but was concentrated among respondents exposed to unfavorable behavioral and environmental conditions. The particularly strong association with indoor smoking suggests that smoke-free household interventions may have relevance beyond conventional tobacco-control objectives. Reducing indoor tobacco smoke may simultaneously improve respiratory health, indoor air quality, and the household environment in which airborne

infections are transmitted. Temperature and humidity findings reinforce the importance of considering housing conditions within community TB control rather than focusing exclusively on case detection and pharmacological treatment.

DISCUSSION

The present study provides context-specific evidence that tuberculosis occurrence in the working area of Fkour Public Health Center is closely associated with household behavioral and environmental conditions. Rather than viewing TB solely as an infectious disease requiring identification and treatment of individual cases, the findings point to the household as an important epidemiological space in which exposure, susceptibility, and environmental conditions interact. Among the 79 participants, 21.5% were classified as having TB based on the study screening procedure. TB occurrence was markedly higher among respondents exposed to indoor smoking, non-compliant household temperature, and non-compliant humidity, and all three factors showed statistically significant associations in the bivariate analysis. This pattern suggests that community TB control in this setting may benefit from integrating environmental and behavioral interventions into conventional case-finding and treatment strategies.

The association with indoor smoking was particularly pronounced. TB was identified in 65.2% of respondents from households categorized as having poor indoor smoking practices, compared with only 3.6% among those in the more favorable category. Conceptually, this finding is important because smoking inside the home may influence TB vulnerability through more than one pathway[11,12]. Tobacco smoke contributes to indoor air pollution and exposes both smokers and non-smokers to respiratory irritants, while repeated exposure may impair local pulmonary defense mechanisms. In a household where infectious respiratory particles may already circulate, smoking therefore represents both an individual respiratory exposure and a shared environmental hazard[13,14]. The implication is that smoking cessation programs and TB prevention should not be implemented as entirely separate public health activities. At the primary-care level, a household identified during TB screening could simultaneously become a target for smoke-free home counseling, family education, and environmental risk assessment.

The findings concerning indoor temperature add another dimension to this interpretation. TB occurred in 57.7% of respondents living in houses where temperature did not meet the recommended environmental standard, compared with 3.8% among those living in houses within the recommended range. Temperature itself should not be interpreted as a direct causal agent of TB. Instead, it may function as an indicator of broader housing conditions, including ventilation, construction characteristics, air circulation, sunlight penetration, occupancy patterns, and local climatic conditions. A household that persistently falls outside an acceptable thermal range may therefore represent a physical environment in which several determinants of respiratory health coexist[15,16]. This distinction is important because interventions should not focus narrowly on achieving a numerical temperature target. The more relevant public health response is to identify the structural conditions producing unfavorable indoor temperature, such as inadequate ventilation or poor airflow, and address them through feasible household modifications.

A similar interpretation applies to humidity. More than half of respondents living in houses with non-compliant humidity were classified as having TB, whereas TB occurred in fewer than one in ten respondents living in houses that met the humidity standard. Humidity may reflect a broader constellation of environmental problems, including dampness, limited sunlight, inadequate ventilation, water intrusion, and restricted air movement[17,18]. Consequently, its value in TB prevention may lie less in treating humidity as an isolated exposure and more in using it as a practical marker of household environmental vulnerability. The original manuscript similarly emphasizes the need to combine humidity control with improvements in ventilation and lighting rather than addressing these conditions separately[19]. This supports a systems-

oriented interpretation in which TB prevention is linked to environmental health, housing quality, behavioral change, and primary healthcare outreach.

These findings are broadly consistent with the body of literature reviewed in the manuscript. Previous studies cited in the thesis have reported associations between tobacco exposure and TB as well as relationships between physical housing conditions and pulmonary TB. The manuscript notes that smoking can damage respiratory defenses and that previous work has found greater TB occurrence among people who smoke or live with smokers. Identified associations involving humidity, temperature, ventilation, lighting, occupancy density, or combinations of these household conditions. Although the exact magnitude of association differs across studies, the general pattern supports the proposition that TB transmission and occurrence are influenced by both host-related behaviors and environmental context[20].

At the same time, the present study contributes something distinct by evaluating these exposures in a relatively underrepresented setting in South Sorong. The working area of Fkour Public Health Center includes geographically dispersed communities with varied housing characteristics and uneven access to health services[21]. The thesis identifies limited local evidence regarding the relationship between household environmental conditions and TB and reports preliminary observations of indoor smoking and houses that did not meet temperature and humidity standards. Evidence from more urbanized or densely populated settings cannot automatically be assumed to operate in the same way in remote areas of Southwest Papua, where housing materials, climate, livelihood patterns, health service accessibility, and daily household practices may differ[22]. The current study therefore extends the existing evidence base by demonstrating that behavioral and environmental household factors are also relevant within this specific local context.

An important conceptual contribution is the possibility that these exposures should be understood as interconnected rather than independent risk domains. Indoor smoking may worsen air quality, while insufficient ventilation may allow smoke and respiratory particles to remain indoors. Poor ventilation can also influence temperature and humidity. Similarly, dampness and inadequate sunlight may coexist with unfavorable thermal conditions. In such circumstances, statistical associations attributed to individual variables may partly represent a broader household environmental profile[23]. This interpretation is especially relevant given the strong magnitude of the observed crude associations and the concentration of TB among participants with unfavorable household exposures. The findings therefore support a shift from single-factor messaging toward integrated household risk reduction[24,25]. A health worker visiting a household for TB contact investigation could assess smoking behavior, ventilation, humidity, temperature, sunlight exposure, and other environmental conditions within the same encounter.

The study also has several limitations that should temper interpretation. First, the cross-sectional design measures exposure and outcome within the same general period and therefore cannot establish temporality. It is not possible to determine from these data whether unfavorable household conditions preceded TB development or whether household behavior changed after the presence of TB became known. The findings should therefore be described as associations rather than causal effects. The original methodology explicitly adopted a cross-sectional design for simultaneous assessment of exposures and outcome.

Second, the sample was relatively small, comprising only 79 respondents, with 17 classified as TB. This limited event count reduces statistical precision and increases the likelihood of unstable effect estimates, particularly when several highly correlated household exposures are considered simultaneously. Any very large odds ratios should therefore be interpreted as evidence of a strong observed association rather than precise estimates of population-level risk. Replication in larger samples is needed before the magnitude of these associations can be generalized.

Third, the outcome definition requires caution. The thesis defines TB status using a screening form, and the abstract refers to presumptive TB cases. Unless bacteriological,

molecular, radiological, or clinically confirmed diagnoses are available for all participants classified as TB, the outcome should not be interpreted as confirmed active tuberculosis. Misclassification is therefore possible. This issue is especially important for international publication because symptom-based screening is intended to identify individuals who require diagnostic evaluation rather than provide definitive diagnosis. Future studies should clearly distinguish presumptive TB, microbiologically confirmed TB, and clinically diagnosed TB.

Fourth, indoor smoking was assessed using questionnaire and observational information, which may be subject to recall and social desirability bias. Objective indicators such as particulate matter concentrations, household nicotine levels, or cotinine biomarkers could provide more precise exposure estimates. Similarly, temperature and humidity were directly measured with a thermohygrometer, which is a strength, but the manuscript does not document repeated measurements across different times of day, seasonal variation, or instrument calibration. A single household measurement may not fully represent long-term environmental exposure.

Another limitation is the absence of several established or plausible confounding variables from the principal analysis. Nutritional status, socioeconomic position, crowding, ventilation area, contact with an infectious TB patient, HIV status, diabetes, previous TB history, occupational exposure, and other determinants may influence both household conditions and TB occurrence. Without comprehensive adjustment, residual confounding remains possible. The observed relationships should therefore be understood as part of a wider causal system rather than interpreted as isolated independent determinants.

Future research should address these limitations through larger prospective or case-control studies with microbiological confirmation of TB and more comprehensive measurement of household and individual determinants. Multicenter recruitment across several districts in Southwest Papua would improve statistical power and external validity while allowing investigators to examine whether associations differ according to geography, housing structure, or access to services. Repeated environmental measurements could capture temporal variability in temperature, humidity, ventilation, and indoor pollutants, and objective monitoring of particulate matter could clarify the contribution of tobacco smoke and indoor air quality.

Future studies should also move beyond identifying associations toward evaluating interventions. Cluster-based community trials or implementation studies could test integrated household packages combining smoke-free home counseling, ventilation improvement, sunlight optimization, environmental monitoring, contact investigation, and rapid diagnostic referral. Such research would be particularly valuable because the current findings suggest that these interventions may have complementary rather than isolated effects. Implementation outcomes such as acceptability, feasibility, household adherence, cost, and sustainability should be assessed alongside epidemiological outcomes.

At the health-system level, the findings support closer integration between TB programs, health promotion, and environmental health services. The recommendations in the original manuscript already emphasize smoke-free homes, ventilation, maintenance of temperature within approximately 18–30°C, humidity within 40–60%, and follow-up evaluation of screening-positive individuals. Operationalizing these recommendations would require primary healthcare teams to view household assessment as part of TB prevention rather than an optional environmental activity. In remote settings such as South Sorong, this integrated approach may be particularly relevant because a single household visit can serve multiple preventive functions. Overall, the study reinforces a broader understanding of TB control: effective prevention depends not only on detecting and treating infection but also on reducing the behavioral and environmental conditions that shape exposure within everyday living spaces.

CONCLUSIONS

This study found that indoor smoking practices and household environmental conditions were significantly associated with tuberculosis occurrence in the working area of Fkour Public Health Center, South Sorong Regency. Tuberculosis was substantially more frequent among respondents living in households with indoor smoking, temperatures outside the recommended range, and non-compliant humidity. These findings indicate that household-level behavioral and environmental conditions are relevant components of community TB prevention, particularly in geographically dispersed and resource-constrained settings.

The findings support a more integrated approach to TB control that combines case finding with household risk reduction. Primary healthcare services should strengthen smoke-free home interventions, promote adequate ventilation and sunlight exposure, monitor household temperature and humidity, and integrate these activities with contact investigation and timely diagnostic follow-up for individuals with positive TB screening results. However, because the study used a cross-sectional design and TB status was primarily screening-based, the observed associations should not be interpreted as causal. Larger studies using confirmed TB diagnoses and longitudinal designs are recommended to validate these findings and evaluate the effectiveness of integrated household environmental interventions.

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Conflict of Interest

The author declares no known financial or personal conflicts of interest that could have influenced the conduct, analysis, interpretation, or reporting of this study.

Authors' Contributions

Medlin D. R. Pakniany: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Visualization, Writing – Original Draft, and Writing – Review & Editing.

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Declaration of Generative AI Use

Generative artificial intelligence tools were used solely to assist with language refinement, academic structuring, and improvement of the clarity of the manuscript. The research design, data collection, statistical data, interpretation of the original findings, and scientific conclusions remained the responsibility of the author. All AI-assisted content was reviewed and revised by the author, who assumes full responsibility for the accuracy and integrity of the final manuscript.

Data Availability Statement

The data supporting the findings of this study are contained within the research dataset and master table generated during the study. The individual-level dataset includes demographic characteristics, indoor smoking practices, household temperature, humidity, and tuberculosis screening status. The data are available from the corresponding author upon reasonable request, subject to applicable ethical and confidentiality considerations.

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