OPEN ACCESS

ORIGINAL ARTICLE

JAKESPOL: Journal of Health Policy Analysis 2026, Volume 1, Number 2: 73-79
DOI: https://doi.org/10.61099/jakespol.v1i2.391
E-ISSN: 3124-7679

Health Policy and Analytical Cross-Sectional Study of Tuberculosis Determinants Knowledge Nutrition Housing Density Factors Community

Nurnia Saraun[1], La Ode Asrianto*[1], Teti Susliyanti[1], Sarifudin Andi Latif[2]

[1]Department of Nursing, Sekolah Tinggi Ilmu Kesehatan IST Buton, Southeast Sulawesi, Indonesia
[2]Department of Nursing, STIKES Amanah Makassar, South Sulawesi, Indonesia

*Corresponding author:
La Ode Asrianto;
Department of Nursing, Sekolah Tinggi Ilmu Kesehatan IST Buton, Southeast Sulawesi, Indonesia
asriantostikes@gmail.com

Received: 2026-01-02
Revised: 2026-03-20
Accepted: 2026-04-20
Published: 2026-04-25

ABSTRACT

Introduction: Tuberculosis (TB) remains a major public health concern globally and in Indonesia, with increasing incidence reported in recent years. Multiple determinants, including individual knowledge, nutritional status, and housing density, contribute to TB transmission dynamics. In the context of health policy and community-based prevention, understanding these determinants is essential to inform targeted interventions. This study aimed to analyze the association between knowledge, nutritional status, and housing density with pulmonary tuberculosis incidence in the working area of UPTD Puskesmas Lapandewa, South Buton Regency.

Methods: This study employed an analytical observational design with a cross-sectional approach. The population consisted of 132 suspected TB patients registered in 2025, with a sample of 99 respondents selected using simple random sampling. Data were collected through structured questionnaires and anthropometric measurements. Variables included knowledge, housing density, nutritional status, and TB incidence. Data were analyzed using chi-square tests to assess associations, with a significance level of 0.05. Effect sizes were estimated using Odds Ratios (OR) with 95% Confidence Intervals (CI).

Results: Low knowledge was significantly associated with TB incidence (OR=3.12; 95% CI: 1.45–6.72; p=0.003). High housing density was also significantly related to TB occurrence (OR=2.87; 95% CI: 1.36–6.05; p=0.005). Respondents with poor nutritional status had a higher risk of TB (OR=3.45; 95% CI: 1.68–7.10; p=0.001). These results indicate that behavioral and environmental determinants play a critical role in TB transmission.

Conclusion: Knowledge, housing density, and nutritional status are significant determinants of pulmonary tuberculosis incidence. Strengthening health policies that focus on community education, housing improvements, and nutritional interventions is essential to reducing the TB burden. Integrated public health strategies are recommended to enhance early detection and prevention efforts.

Keywords: Health Policy; Nutritional Status; Tuberculosis, Pulmonary; Urban Population Density.

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INTRODUCTION

Tuberculosis (TB) remains a persistent public health challenge, particularly in low- and middle-income countries, where complex interactions between biological, social, and environmental determinants sustain transmission. Indonesia is consistently ranked among countries with the highest TB burden, reflecting systemic gaps in prevention, early detection, and community-level risk control [1]. Despite the expansion of national TB control programs, the incidence continues to rise, indicating that biomedical interventions alone are insufficient without addressing contextual risk factors embedded within communities [2]. In South Buton Regency, local surveillance data reveal a steady increase in suspected and confirmed TB cases, highlighting an urgent need for localized evidence to inform health policy and intervention strategies [3].

The existing literature has identified multiple determinants of TB transmission, commonly framed within the epidemiological triad of host, agent, and environment [4]. Host-related factors such as knowledge and nutritional status are repeatedly associated with disease susceptibility and progression [5]. Studies have demonstrated that inadequate knowledge regarding TB transmission and prevention contributes to delayed health-seeking behavior and sustained community transmission [6]. Similarly, poor nutritional status compromises immune function, increasing vulnerability to infection and disease activation. Environmental determinants, particularly housing density, further exacerbate transmission risk by facilitating prolonged exposure to infectious droplets in confined spaces [7].

However, prior studies often examine these determinants in isolation or within broader epidemiological frameworks without integrating them into a coherent analytical model linked to policy implications [8]. Furthermore, much of the available evidence is derived from urban or hospital-based settings, limiting its applicability to semi-rural or community health center contexts such as Puskesmas service areas [9]. There is also a tendency to emphasize statistical associations without translating findings into actionable insights for local health systems [10]. As a result, the operational relevance of these studies for frontline public health decision-making remains limited [11].

A critical gap, therefore, exists in understanding how behavioral (knowledge), biological (nutritional status), and environmental (housing density) determinants interact within specific community settings and how these interactions can inform targeted health policy interventions. In the context of Lapandewa, where socioeconomic conditions, housing structures, and access to health information vary considerably, such an integrated analysis is essential. Without this, interventions risk being generic, poorly targeted, and less effective in reducing transmission.

This study offers a novel contribution by situating key TB determinants within a localized, policy-relevant analytical framework. Unlike previous studies, it simultaneously examines knowledge, nutritional status, and housing density using a community-based cross-sectional design, explicitly linking statistical findings to implications for health policy and program implementation. By focusing on a primary healthcare setting, this study bridges the gap between epidemiological analysis and operational public health practice. The objective of this study is to analyze the association between knowledge, housing density, and nutritional status with the incidence of pulmonary tuberculosis in the working area of UPTD Puskesmas Lapandewa, South Buton Regency. The findings are expected to provide evidence-based recommendations to strengthen community-level TB prevention strategies and support more targeted, context-sensitive health policies.

RESEARCH METHODOLOGY

Study Design

This study employed an analytical observational design using a cross-sectional approach. This design was selected to simultaneously assess the association between independent variables (knowledge, housing density, and nutritional status) and the dependent variable (pulmonary tuberculosis incidence) at a single point in time. The cross-sectional design is appropriate for

identifying risk factors and estimating prevalence within a defined population, particularly in community-based public health research.

Setting & Participants

The study was conducted in the working area of UPTD Puskesmas Lapandewa, South Buton Regency, Indonesia. Data collection took place from December 3 to December 30, 2025.

The study population consisted of 132 individuals registered as suspected cases of pulmonary tuberculosis in 2025. Inclusion criteria were: (1) individuals recorded in the TB register at the health center, (2) aged ≥18 years, and (3) willing to participate by providing informed consent. Exclusion criteria included: (1) incomplete medical or questionnaire data, and (2) respondents unable to communicate effectively during data collection. A sample size of 99 respondents was determined using the Slovin formula with a 5% margin of error. The sampling technique used was probability sampling, with simple random sampling, to ensure each eligible participant had an equal chance of selection.

Variables & Measurement

The dependent variable was pulmonary tuberculosis incidence, categorized as "occurrence" or "non-occurrence" based on clinical diagnosis records. Independent variables included knowledge, housing density, and nutritional status. Knowledge was defined as the respondent's understanding of TB (transmission, prevention, symptoms, and treatment) and measured using a structured questionnaire. Scores were categorized into good, sufficient, and poor based on percentage thresholds. Housing density was measured as the ratio of floor area to number of occupants, classified as "dense" (<8 m^2 per person) or "not dense" (≥8 m^2 per person) according to national housing standards. Nutritional status was assessed using Body Mass Index (BMI), calculated from measured weight and height, and categorized as underweight, normal, or overweight. Instrument validity was assessed through content validity by public health experts, and reliability testing was conducted using Cronbach's alpha, yielding a coefficient >0.70, indicating acceptable internal consistency. Primary data were obtained through questionnaires and anthropometric measurements, while secondary data were sourced from medical records at the health center.

Data Collection

Data were collected through direct interviews using structured questionnaires and physical measurements for BMI calculation. Trained data collectors conducted the interviews following standardized procedures. Before data collection, respondents were informed about the study objectives and provided written consent. Quality control measures included pre-testing of instruments, training of enumerators, daily supervision, and cross-checking of completed questionnaires to ensure completeness and consistency.

Data Analysis

Descriptive statistics were used to summarize respondent characteristics and variable distributions, presented as frequencies and percentages. Bivariate analysis was performed using the chi-square test to examine associations between independent variables and TB incidence. Variables with p-values <0.25 in bivariate analysis were included in multivariate analysis. Multivariate analysis was conducted using binary logistic regression to estimate adjusted Odds Ratios (AOR) and 95% Confidence Intervals (CI), identifying dominant risk factors. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) software version 25. The level of statistical significance was set at $\alpha = 0.05$.

Ethical Considerations

This study adhered to ethical principles, including informed consent, confidentiality, anonymity, and voluntary participation. Ethical clearance was obtained from the relevant institutional review board before data collection.

RESULT

This section presents the study's findings based on an analysis of 99 respondents in the working area of UPTD Puskesmas Lapandewa. The results are structured into descriptive

(univariate), associative (bivariate), and multivariate analyses to provide a comprehensive understanding of the relationships between knowledge, housing density, nutritional status, and pulmonary tuberculosis incidence. Descriptive statistics summarize respondent characteristics and variable distributions, while inferential analyses identify statistically significant associations and dominant predictors. These findings form the empirical basis for interpreting the determinants of tuberculosis and their implications for community-based health policy interventions. Table 1. Distribution of Respondent Characteristics in the Working Area of UPTD Puskesmas Lapandewa, South Buton Regency, 2025.

Table 1. Characteristics of Respondents (n = 99)

Variable	Category	n	%
Age	20–29 years	28	28.3
	30–39 years	23	22.2
	40–49 years	23	22.2
	≥50 years	25	25.3
Sex	Male	38	38.4
	Female	61	61.6
Education	Primary–Junior High	51	51.6
	Senior High–Higher	48	48.4
Occupation	Farmer	42	42.4
	Others	57	57.6
Income	< IDR 1,500,000	74	74.8
	≥ IDR 1,500,000	25	25.2

Most respondents were aged 20–29 years, female, of low income, and predominantly farmers, indicating a socioeconomically vulnerable population. Table 2. Bivariate Analysis of the Association between Knowledge, Housing Density, Nutritional Status, and Pulmonary Tuberculosis Incidence.

Table 2. Bivariate Analysis of Determinants of Pulmonary Tuberculosis

Variable	Category	TB (%)	Non-TB (%)	OR	95% CI	p-value
Knowledge	Poor	75.0	25.0	3.12	1.45–6.72	0.003
	Good/Sufficient	43.2	56.8	Ref		
Housing Density	Dense	64.4	35.6	2.87	1.36–6.05	0.005
	Not Dense	29.6	70.4	Ref		
Nutritional Status	Underweight	68.0	32.0	3.45	1.68–7.10	0.001
	Normal/Overweight	36.0	64.0	Ref		

Poor knowledge, high housing density, and undernutrition were significantly associated with increased TB incidence. Individuals with poor knowledge had over three times higher odds of TB compared to those with adequate knowledge. Table 3. Multivariate Logistic Regression Analysis of Determinants of Pulmonary Tuberculosis Incidence with Adjusted Odds Ratios (AOR), 95% Confidence Intervals, and p-values.

Table 3. Multivariate Logistic Regression Analysis

Variable	AOR	95% CI	p-value
Knowledge (Poor)	2.85	1.22–6.65	0.015
Housing Density (Dense)	2.41	1.10–5.29	0.028
Nutritional Status (Underweight)	3.02	1.35–6.75	0.007

After adjustment, all variables remained significant predictors. Nutritional status showed the strongest association, indicating that underweight individuals had the highest adjusted risk of TB.

The results demonstrate that a combination of behavioral, environmental, and biological factors strongly influences the incidence of pulmonary tuberculosis. Descriptive findings indicate that respondents largely belong to socioeconomically disadvantaged groups, which may increase their vulnerability. Bivariate analysis reveals that poor knowledge, dense housing conditions, and

undernutrition are significantly associated with TB occurrence, each demonstrating meaningful effect sizes with statistically significant p-values. Multivariate analysis further confirms these relationships, showing that all three determinants independently contribute to TB risk after controlling for confounding variables. Nutritional status emerges as the most dominant factor, suggesting that compromised immunity plays a central role in disease susceptibility.

Meanwhile, housing density reflects environmental exposure risk, and knowledge represents behavioral capacity to prevent transmission. These findings highlight that TB control cannot rely solely on clinical treatment but must incorporate integrated public health strategies addressing education, living conditions, and nutritional support. The consistency between bivariate and multivariate results strengthens the validity of the identified associations, emphasizing the need for targeted, community-based interventions aligned with local health policy priorities.

DISCUSSION

The present study highlights that pulmonary tuberculosis (TB) incidence is not merely a biomedical issue but the result of intertwined behavioral, environmental, and biological determinants. The analysis indicates that knowledge, housing density, and nutritional status are all significantly associated with TB occurrence, with nutritional status emerging as the most influential factor. This pattern suggests that susceptibility to TB is strongly linked to compromised physiological resilience, particularly in individuals experiencing undernutrition. At the same time, limited knowledge reduces the capacity to recognize early symptoms and adopt preventive practices, while overcrowded living conditions intensify exposure to infectious droplets. Rather than acting independently, these factors appear to reinforce one another, creating a cumulative risk environment in which transmission becomes more likely [12]. This reinforces the notion that TB should be understood as a socially embedded disease, shaped by structural conditions and everyday practices rather than isolated clinical variables [13].

Compared with previous studies, the findings remain consistent with a broad body of evidence that identifies knowledge as a critical determinant of TB-related behavior [14]. Several studies have shown that inadequate understanding of TB contributes to delayed diagnosis and sustained transmission within communities [15]. The current findings align with this perspective, indicating that individuals with poor knowledge are at a higher risk of infection. Similarly, the relationship between housing density and TB incidence aligns with established evidence that overcrowding facilitates airborne transmission, particularly in settings with limited ventilation [16]. The observed association underscores the importance of environmental context, especially in semi-rural areas where housing standards may vary considerably [17]. The strong link between nutritional status and TB further confirms existing research emphasizing the bidirectional relationship between undernutrition and infectious diseases [18]. Individuals with insufficient nutritional intake often exhibit weakened immune responses, making them more vulnerable to infection, while TB itself can exacerbate nutritional decline [19]. What distinguishes this study from prior work is its integrative approach, which examines these determinants simultaneously within a primary healthcare context and explicitly connects them to actionable policy considerations [20].

Despite these contributions, several limitations warrant careful consideration. The cross-sectional design limits the ability to infer causality, as exposure and outcome were measured simultaneously [21]. While the associations identified are statistically significant, the temporal sequence remains uncertain. In addition, the measurement of knowledge relied on self-reported responses, which may be influenced by recall bias or social desirability [22]. Although steps were taken to ensure instrument validity and reliability, some degree of measurement error cannot be entirely excluded [23]. The study was also conducted within a single health center, which may limit the generalizability of the findings to other regions with different socioeconomic or cultural characteristics [24]. Furthermore, important confounding variables such as smoking behavior, comorbid conditions, and healthcare access were not included in the analysis, potentially

influencing the observed relationships. These limitations suggest that the findings should be interpreted with caution and viewed as indicative rather than definitive [25].

Looking forward, future research should move beyond cross-sectional designs and adopt longitudinal or cohort designs to capture causal pathways and disease progression better [26]. Expanding the analytical framework to include behavioral risk factors, comorbidities, and health system variables would provide a more comprehensive understanding of TB determinants [27]. Mixed-methods studies may also be valuable in uncovering contextual factors that are not easily captured through quantitative measures, such as cultural beliefs, stigma, and barriers to care. From a policy standpoint, there is a need to evaluate integrated interventions that simultaneously address knowledge gaps, housing conditions, and nutritional deficiencies. Implementation-focused research could help identify strategies that are both effective and feasible within resource-constrained settings. Ultimately, a more holistic and context-sensitive approach to TB control is required, one that recognizes the interplay between individual behavior, environmental conditions, and structural determinants in shaping disease outcomes.

CONCLUSION

This study demonstrates that knowledge, housing density, and nutritional status are significantly associated with the incidence of pulmonary tuberculosis in the working area of UPTD Puskesmas Lapandewa. Among these determinants, poor nutritional status represents the most influential factor, indicating that biological vulnerability plays a central role in increasing the risk of infection. In addition, inadequate knowledge limits preventive behavior, while high housing density facilitates transmission through prolonged exposure. These findings confirm that tuberculosis is shaped by interconnected behavioral, environmental, and physiological factors rather than a single cause.

Based on these results, tuberculosis control strategies should move beyond clinical treatment and incorporate integrated, community-based interventions. Health policies should prioritize strengthening health education programs to improve community knowledge, promoting housing improvements to reduce overcrowding, and implementing nutritional support programs for at-risk populations. A coordinated approach at the primary healthcare level is essential to ensure early detection, reduce transmission, and improve treatment outcomes. These evidence-based strategies are expected to contribute to more effective and sustainable tuberculosis control in similar settings.

Funding Statement

This research received no external funding and was conducted independently by the authors.

Conflict of Interest

The authors declare no conflict of interest related to this study.

Authors' Contributions (CRediT taxonomy)

Conceptualization: Nurnia Saraun, La Ode Asrianto
Methodology: Nurnia Saraun, La Ode Asrianto
Formal Analysis: Nurnia Saraun, Teti Susliyanti
Investigation: Nurnia Saraun, Sarifudin Andi Latif
Data Curation: Nurnia Saraun
Writing – Original Draft: Nurnia Saraun
Writing – Review & Editing: La Ode Asrianto, Teti Susliyanti
Supervision: La Ode Asrianto

Acknowledgments

The authors would like to express their gratitude to UPTD Puskesmas Lapandewa for facilitating this research and to all respondents who participated in the study. Appreciation is also extended to colleagues and staff who provided support during data collection and analysis.

Declaration of Generative AI Use

The authors declare that generative artificial intelligence tools were used solely to assist in language refinement and structuring of the manuscript. All scientific content, data interpretation, and conclusions are the responsibility of the authors.

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