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Research Article

Proximate Determinants and Burden of Tuberculosis (TB) in Indigenous People Worldwide: A Systematic Review

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A B S T R A C T

Introduction: Tuberculosis (TB) remains a significant public health challenge, particularly among Indigenous populations worldwide. Indigenous communities often experience socioeconomic disadvantages, including poverty, overcrowding, food insecurity, and limited access to healthcare, all of which contribute to the high burden of TB. This systematic review aims to analyse the proximate determinants and burden of TB among Indigenous populations globally.

Materials and Methods: A systematic review was conducted following PRISMA guidelines. Literature from 1985 to 2022 was searched across multiple databases, including PubMed, Embase, Medline, Cochrane Library, and CINAHL. Eligible studies included observational studies, cohort studies, and qualitative research addressing TB burden and associated determinants in Indigenous communities. Data were extracted based on variables such as TB prevalence, socioeconomic determinants, healthcare access, and regional disparities.

Results: From an initial search of 120,324 articles, 310 were included in the final review. Among them, 210 focused on proximate TB determinants, 20 on TB burden, and 46 on Indigenous populations worldwide. Key findings highlighted high TB prevalence in Indigenous populations, with significant disparities across regions. Overcrowding, malnutrition, excessive alcohol consumption, diabetes, and limited healthcare access were primary contributors. TB incidence was highest among the Saharia tribe in India, the Yanomami in Brazil, and the Fulani in Chad.

Conclusion: Indigenous populations experience disproportionately high TB burdens due to structural and social determinants. Addressing TB among these communities requires targeted public health interventions, improved healthcare access, and culturally sensitive approaches. Collaborative efforts between policymakers, healthcare providers, and Indigenous communities are essential for effective TB control.

Keywords: Indigenous People, Tuberculosis, Social Determinants, HIV, Diabetes Mellitus

Introduction

Indigenous peoples share a historical connection to a specific region and a deep attachment to their ancestral lands. They uphold unique social, economic, and political structures. They are characterisedby distinct languages, cultures, belief systems, and bodies of knowledge. They are conscious about their group identity and solidarity, and hence they are still able to preserve their identity by maintaining their social institutions. Moreover, they constitute a marginalised sector within society.[1]

Across the globe, there are over 476 million indigenous individuals residing in 90 different countries, comprising approximately 6.2 % of the world's total population. Among these indigenous populations, there exist over 5,000 unique and separate groups.[2]

The United Nations (UN) Declaration on the Rights of Indigenous Peoples emphasises that self-identification is a core criterion for recognising indigenous status. The Declaration highlights their right to define their own identity or membership based on their customs and traditions.[3] Indigenous communities around the world have been found to be deprived of adequate representation in decision-making procedures related to issues that have a direct impact on their lives. They are often not consulted regarding initiatives that impact their territories or the implementation of administrative or legal actions that could have consequences for them. Additionally, they are commonly forced to leave their ancestral lands due to activities like natural resource extraction.[1-3]

Social Determinants of TB

The Commission on Social Determinants of Health (CSDH) characterises structural determinants of health as factors that create or amplify social hierarchies within a society. These hierarchies, in turn, lead to an uneven distribution of various factors influencing health, such as living conditions, behaviors, psychological well-being, and biological risk factors.[2]

Critical structural factors influencing the epidemiology of TB encompass worldwide economic disparities, significant population movement, and swift urbanisation and population expansion. These circumstances result in uneven allocations of pivotal social elements impacting TB, such as inadequate access to food and malnutrition, substandard housing and environmental situations, as well as economic, geographical, and cultural obstacles to healthcare.[3]Consequently, the prevalence of TB in the population mirrors the distribution of these social determinants, which, in turn, play a role in all four stages of TB development: exposure to infection, progression to the disease, delayed or inadequate diagnosis and treatment, and suboptimal treatment adherence and outcomes.[4,5]

Social determinants significantly contribute to the risk factors for tuberculosis (TB). Poor ventilation and overcrowding in homes, workplaces, and communities increase the likelihood of TB transmission by facilitating contact between infected and uninfected individuals. Additionally, conditions such as poverty, malnutrition, and food insecurity elevate susceptibility to TB infection and worsen the severity of the disease. Individuals with TB symptoms, such as a persistent cough, often face substantial social and economic barriers that delay their access to healthcare and proper diagnosis. These barriers include difficulties in reaching healthcare facilities, fear of stigma associated with a TB diagnosis, and a lack of social support to seek timely medical attention.[6-8]

While the DOTS (Directly Observed Treatment, Short-Course) strategy leverages patients' social networks to improve treatment adherence, addressing TB through a social determinants framework reveals how poverty and a lack of hope for improved living conditions can lead to high rates of treatment abandonment, undermining TB control efforts. Furthermore, the strong correlation between HIV and TB, particularly in sub-Saharan Africa, highlights how the structural and social determinants of HIV also indirectly influence TB risk. Gender-based disparities, driven by cultural norms and socioeconomic inequalities, exacerbate these challenges. These disparities perpetuate inequities in opportunities and expectations, creating environments conducive to power imbalances and concurrent sexual partnerships, which further impact health outcomes.[9-12]

Methods

Search Strategy

A systematic review of the literature was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to explore the proximate determinants and burden of tuberculosis (TB) among Indigenous populations from January 1, 1985, to 2022. A comprehensive search strategy was developed, utilising a combination of Medical Subject Headings (MeSH) terms, keywords, truncations, and Boolean operators. Search terms included variations of "low socioeconomic or sociodemographic status"," "Indigenous peoples," and "prevalence/epidemiology".[13,14] The strategy was applied to multiple databases, including Embase, PubMed, Medline, Cochrane Library, CINAHL, and Google Scholar. No restrictions were imposed on the searches. Eligible studies encompassed randomised controlled trials, cohort studies, cross-sectional studies, case reports, and

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qualitative research addressing the research question. Only English-language articles were considered.

Eligibility Criteria

Inclusion Criteria

The study adhered to the United Nations definition of Indigenous peoples, which includes self-identification as Indigenous, historical continuity with pre-colonial or pre-settler societies, connections to ancestral territories and natural resources, distinct social, economic, and political systems, unique languages and cultural practices, non-dominance within society, and a commitment to maintaining their ancestral environments and systems. Eligible literature focused on proximate determinants and the TB burden in Indigenous communities, specifically relating to Mycobacterium tuberculosis.

Exclusion Criteria

Studies excluded based on title and abstract included those focusing on notifiable diseases, non-tuberculosis mycobacteria (e.g., leprosy), book reviews, and those without publication dates. Research was also excluded if it concentrated solely on specific age groups, such as children under 15 years or adults over 65 years, or if participants were limited to a particular condition or determinant (e.g., only individuals with diabetes). Studies targeting specific subgroups of Indigenous populations, such as pregnant women or injection drug users, or those evaluating cessation interventions for established recreational tobacco or substance use, were also excluded.

Data Extraction and Analysis

Data were extracted using a standardised abstraction form, categorising articles by WHO geographic regions and further dividing the Americas into North and Latin America. Extracted variables included:

- Study title and country of origin
- Publication year
- Name of Indigenous group(s) studied
- Determinants analysed, with their definitions and measurement methods
- Study design and sampling framework
- Data collection period
- Sample size
- Reported prevalence of TB determinants
- Non-Indigenous comparison groups, if applicable
- Relevant details and results of preventive programmes

No meta-analysis was conducted due to population heterogeneity; results were summariseddescriptively. Excessive alcohol consumption was assessed through questionnaires, medical history, or diagnostic criteria for alcohol misuse and dependence (DSM-IV).[13,14] Crowding was generally defined as having more than one person per room. Malnutrition was determined using a body mass index (BMI) of less than 18.5 kg/m². Food insecurity was measured through validated questionnaires and scoring systems. Diabetes was defined according to the American Diabetes Association guidelines.[15-17]

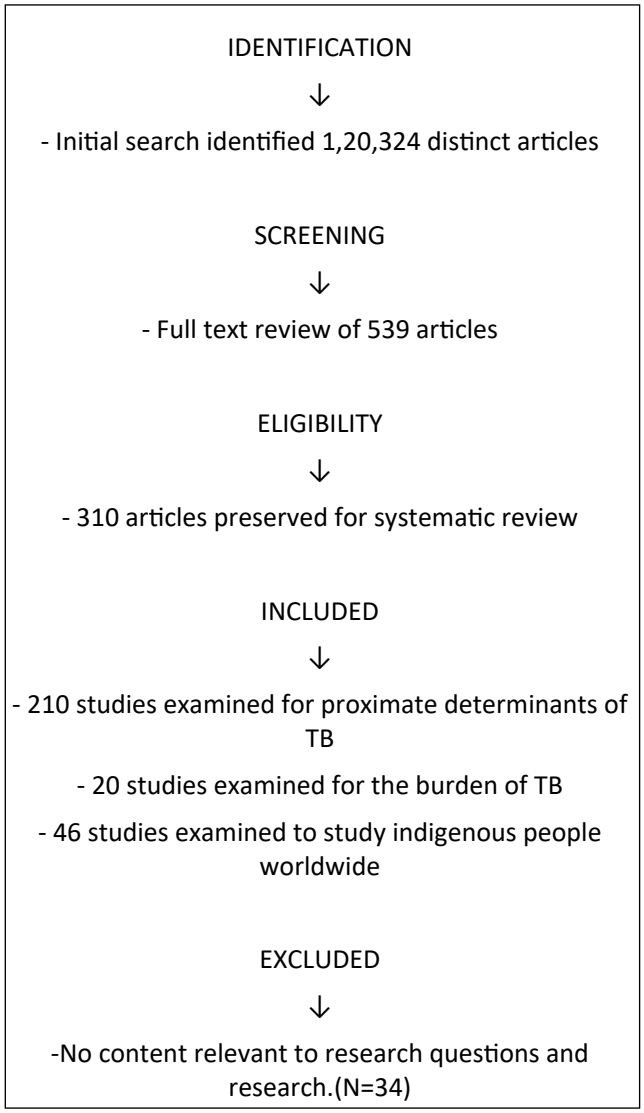

Figure 1.Prefer reporting items for systematic review flow diagram, proximate determinants of TB burden

Results

Search Findings

The initial search identified 120,324 unique articles. Following a full-text review of 539 articles, 310 were included in the systematic review. Of these, 210 studies focused on proximate determinants of TB, 20 examined the burden of TB, and 46 explored Indigenous populations globally. PubMed served as the primary database for searches on TB and its burden in Indigenous communities across different regions (Table 1, 2).

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Table 1.Characteristics of Included Studies

Author (Year)	Country/ Region	Indigenous Group	Study Design	TB Prevalence/ Incidence	Determinants Assessed
Tollefson et al. (2013)	Global	Multiple	Systematic Review	Variable by group	Overcrowding, alcohol, diabetes
Thomas et al. (2015)	India	Saharia tribe	Meta-analysis	730/100,000	Malnutrition, crowding
FitzGerald et al. (2000)	Canada	First Nations	Cohort	Higher than national avg	Smoking, poor housing
Holm et al. (2010)	USA	American Indians	Cross-sectional	Elevated	Diabetes, alcohol
Carrasco-Garrido et al. (2011)	Spain	Roma women	Survey	Not specified	Poor housing, HIV

Table 2.Summary of Proximate Determinants by Region

Region	Common Determinants	TB Incidence/Prevalence Range	Key Indigenous Groups
Africa	Overcrowding, poverty, low access to care	1,800–4,000 per 100,000	Fulani (Chad), Peul (Mali)[24]
South-East Asia	Malnutrition, crowding, poverty	Up to 100x national avg	Saharia (India)[33-35]
Americas (North)	Diabetes, smoking, crowding	Declining trend, still high	First Nations, AI/AN[25-30]
Americas (Latin)	HIV, poverty, malnutrition	>1,000 per 100,000	Yanomami (Brazil), Garifuna (Honduras)[31]
Western Pacific	Alcohol use, diabetes, HIV	Variable	Aboriginal Australians[18-20,22]
Europe	Overcrowding, poor housing	Low–moderate	Roma/Gypsy populations[21-23]

Alcohol Use Patterns

Alcohol use prevalence varied between Indigenous and non-Indigenous populations. Among non-Indigenous populations, regular alcohol use, alcohol misuse, and binge drinking were more prevalent in men compared to women. However, among Indigenous populations, alcohol use patterns appeared more evenly distributed between genders. Binge drinking was less common in Indigenous populations residing in high-income countries such as the United States, Canada, and Australia compared to non-Indigenous populations.[18-20] Preventive programs addressing alcohol use were notably absent.[15] Overcrowding Most studies on overcrowding originated from North America, where overcrowding, defined as more than one person per room, was more prevalent among First Nations communities on reserves. Globally, data indicate overcrowding rates of 20.3–58.3% among India's Scheduled Tribes, 37% among Slovakia's Roma populations, and 25.1–57.5% among Indigenous groups in North America. Poor housing conditions were reported at rates of 62.2% in Europe among the Roma and 7% in North America. The Western Pacific region reported overcrowding rates of approximately 37%.[21] Diabetes Prevalence

Higher diabetes prevalence was observed among Indigenous populations in high-income countries compared to those in low-income regions. Native American tribes in the United States showed diabetes prevalence rates ranging from 2.0% to 71.0%, the highest globally. Conversely, the lowest rates were reported among Malaysia's Orang Asli (0.3%), Brazil's Amerindians (0.1%), and Scheduled Tribes in Central India (0.38%). Australian Aboriginal and Torres Strait Islander populations exhibited diabetes prevalence rates between 4% and 54.2%, compared to 1.9–7.0% among non-Indigenous Australians. In North America, Alaska Natives, Native Hawaiians, and Native Americans reported prevalence rates of 2–71%, compared to 2.5–16.5% among non-Indigenous populations.[18] HIV Prevalence

HIV prevalence among Indigenous populations was most frequently studied in Native American communities, with rates ranging from 0.10% to 10%. The highest prevalence

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globally was recorded among Australian Aboriginal populations in the Western Pacific (9.7 per 10,000). In Latin America, Honduras' Garifuna people exhibited an HIV prevalence of 4.5%, compared to 0.12% among Indigenous groups in Argentina. In Europe, Indigenous Roma and Gypsy populations showed negligible HIV prevalence, ranging from 0% in Hungary to 0.5% in Bulgaria.[22,23] Regional TB Burden

- **Africa:** Despite the substantial Indigenous population (approximately 14.2 million), TB prevalence was remarkably high, with rates of 4,000 per 100,000 among Chad's nomadic Fulani people and 1,800 per 100,000 among the Peul and Dogon populations in Mali.[24]Americas:
- **North America:** Indigenous groups such as First Nations, Métis, and Inuit in Canada and American Indians (AI), Alaskan Natives (AN), Native Hawaiians (NH), and Pacific Islanders (PI) in the United States demonstrated higher TB incidence compared to non-Indigenous populations. However, incidence rates among both groups have decreased over the past two decades.[25-30]
- **Latin America:** The Brazilian Amazon's Indigenous populations, particularly the Yanomami, reported TB incidence rates exceeding 1,000 per 100,000, significantly higher than the general population. In Ecuador's Cotopaxi Province, TB prevalence reached 6,700 per 100,000.[31]
- **Europe:** Studies in Greenland revealed that the incidence of active TB among Inuit populations rose from 85 to 185 cases per 100,000 people between 1990 and 2001. Inuit populations were found to have a 15.3-fold higher risk of active TB compared to the Danish population.[32]
- **South-East Asia:** Tribal populations in India demonstrated a disproportionately high TB burden. The Saharia tribal group reported prevalence rates up to 100 times greater than the national average. In Maharashtra, active TB prevalence reached 730 per 100,000 among certain tribes, compared to provincial estimates.[33-35]

Risk Factors and Social Determinants

Studies highlighted the role of social determinants such as poverty, malnutrition, and overcrowding in driving TB prevalence.[36] Decreased housing affordability, linked to elevated TB risk among homeless populations, was documented in recent research by Lee et al.[37] Interventions tailored to address these factors could mitigate the TB burden.[37-39]

High Burden TB Country List 2023

High burden countries are those which had TB incidence rates of ≥ 20/100,000 population. They are presented in Table 3.

Table 3.Data obtained from 2022 WHO Global Tuberculosis Report and reflects 2021 data

Country	Country	Country	Country
Afghanistan	Ecuador	Maldives	Solomon Islands
Algeria	El Salvador	Mali	Somalia
Angola	Equatorial Guinea	Marshall Islands	South Africa
Anguilla	Eritrea	Mauritania	South Sudan
Argentina	Eswatini	Mexico	Sri Lanka
Armenia	Ethiopia	Micronesia	Sudan
Azerbaijan	Fiji	Mongolia	Suriname
Bangladesh	Gabon	Morocco	Tajikistan
Belarus	Gambia	Mozambique	Thailand
Belize	Georgia	Myanmar	Timor-Leste
Benin	Ghana	Namibia	Togo
Bhutan	Greenland	Nauru	Tunisia
Bolivia	Guam	Nepal	Turkmenistan
Bosnia and Herzegovina	Guatemala	Nicaragua	Tuvalu
Botswana	Guinea	Niger	Uganda
Brazil	Guinea- Bissau	Nigeria	Ukraine
Brunei Darussalam	Guyana	Niue	United Republic of Tanzania
Burkina Faso	Haiti	Northern Mariana Islands	Uruguay

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Burundi	Honduras	Pakistan	Uzbekistan
Cabo Verde	India	Palau	Vanuatu
Cambodia	Indonesia	Panama	Venezuela
Cameroon	Iraq	Papua New Guinea	Vietnam
Central African Republic	Kazakhstan	Paraguay	Yemen
Chad	Kenya	Peru	Zambia
China	Kiribati	Philipines	Zimbabwe
China, Hong Kong SAR	Kuwait	Quatar	
China, Macao SAR	Kyrgyzstan	Republic of Korea	
Colombia	Lao People's Democratic Republic	Republic of Moldova	
Comoros	Lesotho	Romania	
Congo	Liberia	Russian Federation	
Cote d'Ivorie	Libya	Rwanda	-
Democratic People's Republic of Korea	Lithuania	Sao Tome and Principe	
Democratic Republic of Congo	Madagascar	Senegal	
Djibouti	Malawi	Sierra Leone	
Dominican Republic	Malayasia	Singapore	

Individuals originating from the listed countries should undergo screening for tuberculosis (TB) and TB infection. Those from countries not included on this list should be tested only if they exhibit symptoms or possess identifiable risk factors.

Discussion

This systematic review represents a novel effort to explore the proximate determinants and the burden of tuberculosis (TB) among Indigenous populations globally. The findings indicate that TB determinants and associated burdens vary significantly across regions. Notably, Indigenous populations exhibit higher rates of tobacco use and excessive alcohol consumption compared to non-Indigenous groups. Additionally, diabetes prevalence appears higher among Indigenous communities in high-income countries compared to those in low-income regions.

The analysis, spanning 1985 to 2022, provides a valuable temporal perspective. However, variability in trends due to inconsistent routine surveillance studies among Indigenous populations under programmatic conditions should be considered. Data on overcrowding, housing conditions, malnutrition, and HIV prevalence remain insufficient to draw firm conclusions. Recent evidence suggests that Indigenous groups such as the Ache in Paraguay, the Yanomami in Brazil, the Saharia tribe in India, and the Fulani in Chad bear the heaviest TB burden. Conversely, Aboriginal Australians, American Indians/Alaska Natives, and the Métis of Canada report comparatively lower TB incidence rates.[21,34] Encouragingly, some Indigenous populations, such as Australian Aborigines, Taiwanese Aborigines, and Russia's Northern peoples, have experienced a decline in TB burden over time. These persistent disparities underscore the urgency of addressing TB burden among Indigenous populations through targeted global TB control strategies.[21,34] The strengths of this study include a robust and comprehensive search strategy with rigorous eligibility criteria. However, several limitations must be acknowledged. These include inconsistencies in defining proximate determinants and Indigenous populations, variation in study designs, and geographical disparities. Moreover, limiting the review to English-language studies may have excluded relevant data on Indigenous groups, resulting in potential selection bias. External factors such as evolving national TB programs and the globalization of TB initiatives, along with unpublished data, further restrict the study's scope.

When comparative data were unavailable, TB prevalence and incidence estimates published by the World Health Organization (WHO) were used. However, these national estimates may not fully represent non-Indigenous populations residing near Indigenous communities, thereby limiting direct comparisons. Additionally, the literature predominantly focuses on Indigenous populations in high-income regions, such as North America, Europe, and the Western

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Pacific. Europe and Western Pacific region. Despite many studies addressing the prevalence of diabetes and recreational tobacco.[8-10]

Although substantial research exists on the prevalence of diabetes and tobacco use among Indigenous populations, preventive programs addressing these gaps remain underrepresented. Community-driven approaches are urgently needed to address the TB burden alongside other health challenges. This review emphasizes the importance of culturally informed, community-based strategies to tackle smoking, alcohol use,[24] diabetes, food insecurity, malnutrition, chronic diseases,[30] substance misuse, HIV, and overcrowding. Such public health interventions are essential to mitigate the disproportionate TB burden among Indigenous populations worldwide.

In comparison to the 2019 study published in The Lancet Global Health by Cormier et al.,[40] titled "Proximate determinants of tuberculosis in Indigenous peoples worldwide: a systematic review," our current study offers several key advancements. While the Lancet study provided an important synthesis of TB risk factors among Indigenous populations, it included literature only up to 2018 and faced limitations in drawing reliable conclusions regarding certain determinants such as overcrowding, HIV, and housing conditions due to insufficient data. In contrast, our review spans a broader timeline, covering studies from 1985 to 2022, thereby incorporating the most recent evidence, particularly from the last five years when several regional and national studies emerged.

Moreover, our study places a stronger emphasis on disaggregating proximate determinants such as overcrowding, alcohol use, diabetes, HIV prevalence, and malnutrition across specific Indigenous groups and global regions. This regional stratification allows for a more nuanced understanding of how these determinants vary geographically, which was relatively limited in the 2019 review. Importantly, our review addresses underrepresented regions, including Africa, South-East Asia, and Latin America, where emerging data highlight high TB burdens among Indigenous communities such as the Saharia tribe in India and the Fulani in Chad—populations that received limited attention in the earlier review.

Finally, while the Lancet study focused largely on identifying risk factors, our work goes further by highlighting the critical absence of preventive public health programs—such as alcohol cessation, diabetes screening, and culturally tailored health interventions—among Indigenous populations. This emphasis on intervention gaps adds a new dimension to the existing literature and provides actionable insights for public health planning and TB elimination strategies.

Conclusion

This systematic review highlights significant disparities in TB prevalence among Indigenous communities, emphasizing the disproportionate burden in specific regions and ethnic groups. These findings underscore the critical need for customized interventions and global TB control strategies that prioritize Indigenous populations.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: None

Abbreviations: TB: Tuberculosis, HIV: Human immunodeficiency virus, PRISMA: Prefer reporting items for systematic review and meta-analysis, UN: United Nation, CSDH: Commission on Social Determinants of Health (CSDH), DOTs: Directly Observed short course, WHO: World Health Organization, DSM: Diagnostic and Statistical Manual of Mental Disorder [DSM IV], USA: United State of America, AI: American Indian, AN: Alaskan Native, NH: Native Hawaiians, PI: Pacific Islanders

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