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Uncovering the Causes of Tuberculosis in Small Towns and Villages of Punjab: Socio-Environmental and Health Determinants

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Abstract

Tuberculosis (TB) is one of the major public-health challenges in India. As per the national and state level reports, there are many micro level factors that are playing vital role in spreading TB in small towns and villages these are like household environment, fuel use, housing quality, nutrition and health problems like diabetes and other chronic diseases. This paper bring together the existing research on the social, environmental and health factors linked to TB in the rural area of Punjab and also suggests a community based detailed study to find the risk factors cause to make it as a very common dreadful disease and what improvement can be made by the involvement of local committees and policies. Key drivers include under nutrition, household, air pollution from solid fuels, overcrowded and poor housing, tobacco and alcohol use, diabetes, and gaps in diagnosis and treatment access. The suggested policies are to improve nutrition support, promote the faster use of clean fuels, make housing and ventilation better, and increase TB detection through community-based efforts.

Keywords: tuberculosis, Punjab, rural health, household air pollution, under nutrition, diabetes, TB determinants, tuberculosis incidence

1. Introduction

Tuberculosis (TB), is a highly communicable disease which caused by bacteria known as Mycobacterium tuberculosis. For many years it becomes one of the most significant challenges in the field of global health sector. As the medical and health sector advanced a lot with the fast pace of technology, advanced diagnosis and treatments are available today across the world. In spite of all the advanced measures, TB remains a major cause of infectious disease related mortality with 10.6 million new cases and 1.3 million deaths reported worldwide in 2022 [34].India contributes the heaviest global burden with nearly one fourth of all cases occurring worldwide. The persistence of the burden of TB in India shows that its root causes extend beyond biomedical factors. Factors such as poverty, malnutrition, overcrowded housing, environmental pollution, and limited access to quality healthcare contribute significantly to its persistence, reflecting the interplay of social, environmental, and health-related vulnerabilities [19].

Punjab is one of the richest states in India, agriculturally, medically and technologically advanced comparatively many other states of the country, still it has a unique paradox. TB remains a serious concern in Punjab especially in villages and semi-urban areas. As per the report in various districts shows a variable record and rural and small towns are severely affected [35]. A study revealed that the determinants in these areas are overcrowded housing, widespread use of biomass fuels, high levels of under nutrition, alcohol and tobacco use, and number of people are developing diabetes over time.[33],[36].the existing vulnerabilities are faced by the restricted access of healthcare including social stigma which often discourages individuals from seeking timely medical help, inadequate availability of diagnostic facilities in remote and rural areas and limited resources for early detection and effective treatment.

Although substantial research exists, the current literature in TB in India disproportionately emphases urban populations or depends on broad aggregated data at the district or state level. As a result the micro level determinants that causes TB transmissions and persistence in small towns and rural communities in Punjab remain underexplored. The objective of this research is to uncover the socio-environmental and health determinants explicitly to these communities, addressing the knowledge gap is essential for developing context-specific interventions within India's National Tuberculosis Elimination Programme (NTEP).

A. Sub Regional TB Burden in Punjab

Tuberculosis continues to show an uneven footprint across Punjab. Data indicates that Ludhiana remains the epicentre of the state's TB crisis. In 2019, a study between January and October reveals that the district alone accounted for the 26% of all reported 12633TB cases in private and government hospitals [41]. Other high burden districts including, Amritsar, Jalandhar and Patiala collectively contribute more than half of Punjab's caseload. Despite these districts comprise 36% of state's population [41].

In terms of epidemiological progress Punjab has recorded a significant reduction in tuberculosis incidence, declining from 196 cases per lakh population in 2019 to 163 per lakh in 2021[42]. Several districts achieved substantial decreases of 20% such as Mansa,Kapurthala ,Nawanshahar, Ludhiana , Batinda, TaranTaran[42]. However the district Muksar shows a rise of 4.3%.[42]. A recent active screening initiative conducted across 10 districts indicated that Faridlot reported the highest number of newly diagnosed TB cases [43].

Table1: District-wise changes in TB incidence in Punjab (2019–2021). Source: Times of India 2022

District	**TB Incidence Trend (2019–2021)**	**% Change(Approx.)**
Mansa	Declined significantly	45% ↓
Kapurthala	Declined	26% ↓
Nawanshahr (SBS Nagar)	Declined	30% ↓
Ludhiana	Declined	24% ↓
Bathinda	Declined	23% ↓

District	TB Incidence Trend (2019–2021)	% Change(Approx.)
Tarn Taran	Declined	21% ↓
Sri Muktsar Sahib	Increased	4.3% ↑

The Following bar chart showing the percentage change for each district:

Fig1: Percentage Change by District

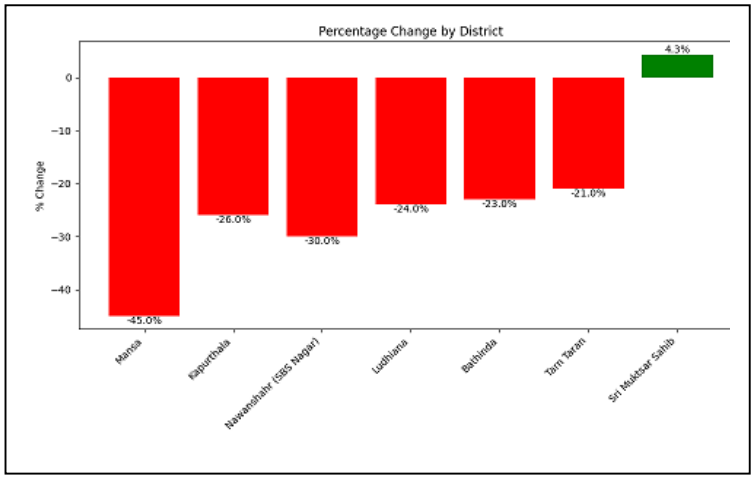

Fig1: Percentage Change by District

• Red bars indicate a negative change.

• Green bar (Sri Muktsar Sahib) indicates a positive change.

The graph shows that the districts Mansa, Nawanshahar (SBS Nagar) and Kapurthala exhibit a rapid decline in TB incidence. It may be the positive outcomes of targeted public health measures or improvements in social and environmental determinants, making them important reference points for analysis. The rising TB trends in Sri Muksar Sahib indicate the possibility of area specific health risk or inefficiency in local programmes, requiring an urgent need for targeted evaluation and corrective action.

2. LITERATURE REVIEW

A. Socio Economic and Nutritional Determinants

In India, under nutrition is one of the main causes of tuberculosis, contributing to nearly half of the newly reported cases each year [5]. Individual with low body mass index (BMI) have weaker immune system, which makes it easier for TB infection to become active. Even in Punjab where agriculture is

strong rural community still suffer from poor nutrition [20]. The interplay between nutritional deficiency and poverty further heightens disease vulnerability by restricting timely healthcare access and irregular treatment [32].

B. Housing, Crowding, and Environmental Conditions

Poor housing conditions play a major role in the spread of tuberculosis. Living in kaccha houses with little ventilation and crowding creates an environment where TB bacteria can easily spread from one person to another [29]. In Punjab's rural villages, large joint families often share small living spaces, which increase the chances of infection. Seasonal migration of workers further adds to this risk, as they are often exposed to unsafe or overcrowded living conditions [37].

C. Indoor Air Pollution

Household air pollution caused by the combustion of solid fuels like firewood, dungcake and crops residues remain significant determinants of tuberculosis incidence [13] . Women in rural areas are particularly vulnerable, given their prolonged exposure to smoke in poorly ventilated kitchens. Although government initiatives like PrdanMantriUjjwallaYojana (PMUY) have expanded access to clean fuels such as LPG, economic constraints often limit consistent adoption [36]. Empirical evidence suggests that individual in solid fuel dependent households are 1.5 to 2 times more likely to develop TB compared to those using clean fuels [38].

D. Behavioural Risks: Tobacco and Alcohol

Smoking and drinking both make tuberculosis harder to prevent and treat. Tobaco use raises the chance of getting infected and worsen recovery, while excessive conception of alcohol weakens the immune system and causes people to skip their medicines [21], [28]. In Punjab ranking among India's leading states in alcohol consumption, these interlinked habbits pose a major challenge for TB control strategies [33].

E. Concurrent illnesses: Diabetes and Other Conditions

According to a study people with diabetes are about three times more likely to develop active TB[1] ;[4]. This is a serious concern in Punjab, where diabetes is more common than in many other parts of India. When TB and diabetes occur together, treatment become more difficult and the chances to relapse or death increases. Other long term diseases like COPD also make people more vulnerable to TB [18].

F. Healthcare Access and Programmatic Challenges

In rural India, the fight against tuberculosis still faces deep rooted obstacles. At many primary health centres, the absence of rapid testing delays the start of treatment [35]. The Nikshay Poshan Yojna, meant to give Nutritional help to TB patients, is not always implemented properly [39]. Social stigma also stops many women and disadvantaged people from going to clinic for treatment [40].

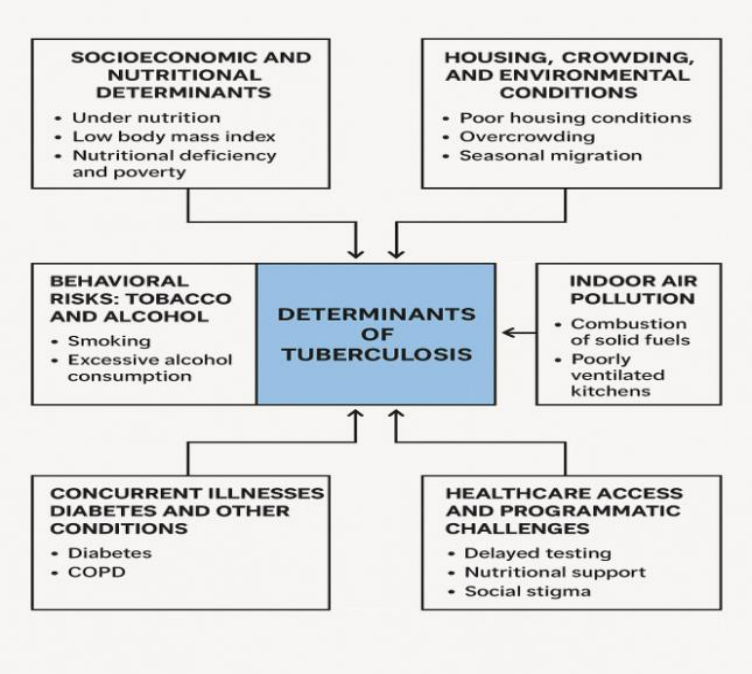

Fig2: Determinants of Tuberculosis

The diagram highlights how social, environmental and health factors collectively drive TB transmission. Poor nutrition, poverty, overcrowding, indoor pollution, smoking alcohol use and chronic diseases such as diabetes and COPD and inadequate healthcare access all contribute to the problem. The overlapping effect of these factors make TB controls a complex challenge that requires collective community efforts.

3. METHODOLOGY

A. TB Risk Factors

Although TB risk factors are well studied across India, little is known about how they affect people in Punjab's small towns and villages. Most research looks at data for entire states or districts, missing local differences in risk. Evidence connecting malnutrition. Indoor smoke, alcohol use and other health problems to TB in Punjab are still limited Social and cultural issues like stigma, migration and gender barriers are also rarely studied. This lack of local information makes it hard to develop programmes that fit to the community, showing the need for detailed, village level research.

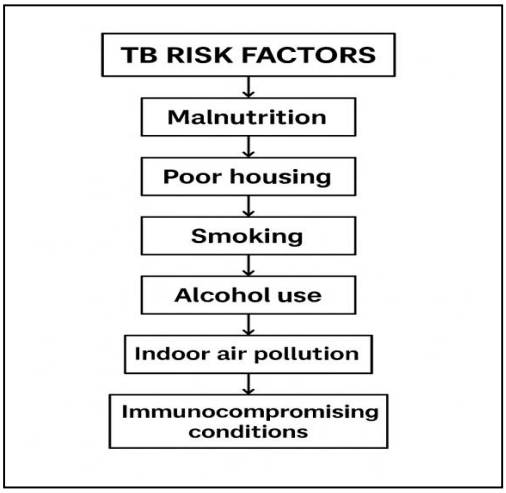

Fig 3: Steps TB Risk

B. Prevention strategies flowchart

The chart shows main reasons people are at risk of tuberculosis and how these risk can be reduced. Problems like malnutrition, poor housing, and smoking indoor pollutionand weak immune system make people more likely to get TB. By eating healthy food, living in better homes, quitting smoking, using clean fuels and managing other health problems can help to lower chances of getting TB. Living a healthier life style and avoiding alcohol can also help to strengthen the body to resist such diseases.

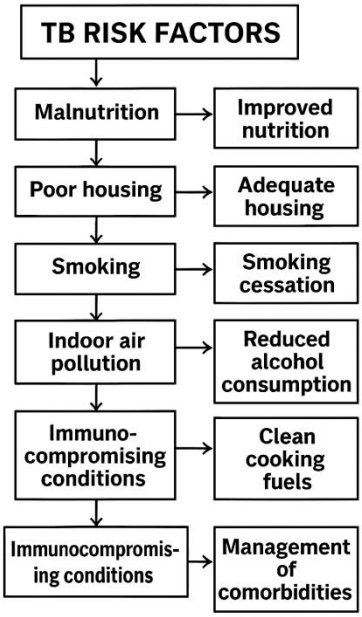

Fig 4: Prevention strategies

C. Prevention strategies for tuberculosis

Preventing tuberculosis requires more than just medicine, it always matter how people live and the environment they inhabit. Promoting a balance diet rich in protein, vitamins and minerals is essential for strengthening immunity especially in TB patients. The people can benefit it from government schemes like Nikshay Poshan Yojana that provides nutritional support during treatment. Improving housing conditions by encouraging the construction of well ventilated pucca homes and reducing overcrowding through awareness and housing programmes can significantly curb the spread of infectious diseases like TB. Expanding access to clean cooking fuels under Pradan Mantri Ujjwala Yojana is equally important as it helps to reduce indoor air pollution caused by solid fuels, which is severely affect the respiratory organs. Other than these initiatives, strong behaviour inventions like public campaigns against tobacco and alcohol use coupled with accessible counselling and rehabilitation services are necessary to support individuals in making healthier lifestyle choices that prevent illness and promote a healthy long life.

Fig 5: Prevention strategies for tuberculosis

D. Predicted TB Risk by Village

Figure 6 presents the predicted tuberculosis (TB) risk in three high-risk villages (A, B, and C), while low-risk or green zones are confined to very limited area. The colour coded map enables the health care professionals to identify areas that required targeted intervention allocate resources effectively and implement strategic prevention and control measures to combat the spread of tuberculosis.

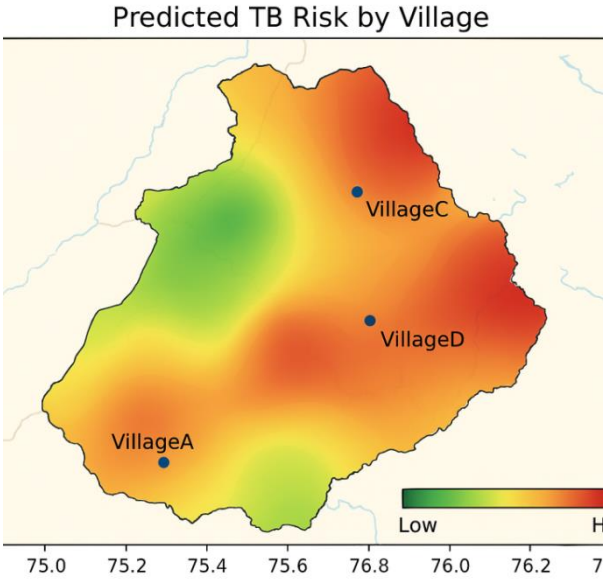

Fig 6: Predicted TB risk by village

4. CONCLUSION

In Punjab's small towns and villages, TB is influenced by both social and environmental factors as well as underlying health conditions. Fighting the disease effectively requires a holistic approach that combined medical treatment with improvements in nutrition, housing, clean energy access and management of chronic illnesses. This study provides the local evidence needed to design interventions that are both targeted and sustainable under the NTEP.

References

1. Jeon, C. Y., & Murray, M. B. (2008). Diabetes mellitus and active TB risk. PLoS Medicine. https://pubmed.ncbi.nlm.nih.gov/18630984/
2. Lönnroth, K., et al. (2010). Drivers of TB epidemics: The social perspective. The Lancet, 375(9728). https://pubmed.ncbi.nlm.nih.gov/19394122/
3. Sreeramareddy, C. T., et al. (2014). Smoking and pulmonary TB risk. BMC Public Health. https://bmcpublichealth.biomedcentral.com/articles/
4. Harries, A. D., et al. (2016). Diabetes and tuberculosis: Global perspective. Lancet Infectious Diseases, 16(9). https://pmc.ncbi.nlm.nih.gov/articles/PMC5240796
5. Padmapriyadarsini, C., et al. (2016). Undernutrition and TB in India. Indian Journal of Medical Research.. https://pmc.ncbi.nlm.nih.gov/articles/PMC5116882/

6. Singh, G., et al. (2018). Housing and TB transmission in India. Indian Journal of Community Medicine, 43(2). https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-022-12879-6
7. Kumar, A., et al. (2018). Indoor air pollution in India and TB risk. Environmental Science & Technology, 52(10). https://onlinelibrary.wiley.com/doi/abs/10.1111/ina.12756
8. Prasad, B., et al. (2018). Migration and TB risk. Journal of Epidemiology and Community Health.
9. Wang, L., et al. (2018). Socio-environmental drivers of TB globally. The Lancet Public Health.
10. Chakrabarti, S., et al. (2019). Alcohol use and TB mortality in India. Addiction, 114(3).https://bmcinfectdis.biomedcentral.com/articles/10.1186
11. Nair, D., et al. (2019). Nutrition-TB link in India. Public Health Nutrition, 22(6),
12. Tripathy, J. P., et al. (2020). Air pollution and TB incidence. Environmental Research
13. Patel, A., et al. (2020). Household air pollution and TB. Environmental Health Perspectives..https://pubmed.ncbi.nlm.nih.gov/33016379/
14. Barik, A., et al. (2020). Socioeconomic inequality in TB prevalence. BMJ Open..
15. Gupta, R., et al. (2020). Malnutrition and TB progression. Clinical Nutrition.
16. MacNeil, A., et al. (2020). Global epidemiology of TB. International Journal of Tuberculosis and Lung Disease. https://pubmed.ncbi.nlm.nih.gov/32191687/
17. Rao, S., et al. (2020). TB-diabetes co-management in India. Indian Journal of Endocrinology and Metabolism.
18. Lin, H. H., et al. (2020). COPD and TB susceptibility. Chest, 158(1),
19. Bhargava, A., et al. (2021). Social determinants of tuberculosis. The Lancet Global Health.
20. NFHS-5. (2021). National Family Health Survey (Punjab State Report). Ministry of Health & Family Welfare.
21. Jindal, S. K., et al. (2021). Smoking and TB in India. Lung India. https://pubmed.ncbi.nlm.nih.gov/16482950/
22. Datta, S., et al. (2021). Stigma and TB care-seeking in India. Social Science & Medicine.
23. Jain, A., et al. (2021). Rural healthcare infrastructure and TB. Indian Journal of Public Health.
24. Lahariya, C., et al. (2022). National TB elimination strategies. Indian Journal of Medical Research..
25. NTEP. (2022). Operational Guidelines for TB Elimination. Ministry of Health, India.
26. Sharma, V., et al. (2022). Community stigma and TB in women. BMC Women's Health.
27. Vashishtha, R., et al. (2022). Gender disparities in TB care access. Journal of Global Health.
28. Bhargava, A., et al. (2022). Alcohol use and TB treatment outcomes. International Journal of Tuberculosis and Lung Disease.https://pubmed.ncbi.nlm.nih.gov/33016808/
29. Lee, J., et al. (2022). Housing and TB: A review. BMC Infectious Diseases,.
30. Mishra, R., et al. (2023). Rural-urban disparities in TB care. Tropical Medicine & International Health.
31. Tiwari, R., et al. (2023). Nutrition supplementation in TB control. Frontiers in Public Health.
32. Barve, S., et al. (2023). Nutritional support and TB outcomes in India. Indian Journal of Public Health.https://www.sciencedirect.com/science/article/pii/S2214109X23003248

33. Singh, J., et al. (2023). Diabetes and TB in Punjab. Journal of Clinical and Diagnostic Research.
34. WHO. (2023). Global Tuberculosis Report 2023. World Health Organization.
35. Government of India. (2024). India TB Report 2024. Ministry of Health & Family Welfare.https://tbcindia.mohfw.gov.in/2024/10/11/india-tb-report-2024/
36. Sahu, P., et al. (2024). Clean fuel and TB risk in rural India. International Journal of Environmental Research and Public Health, 21(6)https://ojs.acad-pub.com/index.php/EPHR/article/view/2652
37. Schwalb, A., et al. (2024). Subnational TB burden in India. PLOS ONE, 19(3)
38. Yadav, A., et al. (2024). Solid fuel use and TB risk. International Journal of Tuberculosis and Lung Disease, 28(1)https://pmc.ncbi.nlm.nih.gov/articles/PMC11687053/
39. Jeyashree, K., et al. (2024). Evaluation of Ni-kshayPoshanYojana. BMC Public Health, 24(1)https://pmc.ncbi.nlm.nih.gov/articles/PMC11265306/
40. Kirubi, B., et al. (2025). Pharmacies and TB program implementation. BMJ Global Health, 10(2).https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-024-12202-6
41. Every fourth TB case in state is from Ludhiana,(2019) www.tribuneindia.com/news/archive/punjab/every-fourth-tb-case-in-state-is-from-ludhiana-867542/amp?utm_source=chatgpt.com
42. Tb Incidence Rate In Punjab Declines By 17%, Chandigarh News - Times of India (2022). https://timesofindia.indiatimes.com/city/chandigarh/tb-incidence-rate-in-punjab-declines-by-17
43. Survey finds 420 TB patients in 10 districts (2022). https://www.tribuneindia.com/news/archive/chandigarh/survey-finds-420-tb-patients-in-10-districts