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Tuberculosis incidence in Saharia tribe of Madhya Pradesh and its implications for public health interventions

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Abstract

Background Tuberculosis (TB) continues to pose a major public health threat in India, particularly among marginalized communities such as the Saharia tribe in Madhya Pradesh. This study presents a district-wise analysis of TB incidence within this vulnerable population.

Methods A cross-sectional study was conducted between December 2018 and March 2021 across seven Sahariadominant districts in Madhya Pradesh, India encompassing 1,814 villages and 120,896 households. Individuals aged 15 years and above ($n=324{,}474$) were screened, with 57,174 undergoing TB testing. Presumptive TB cases were identified through systematic screening and confirmed a TB case via sputum smear microscopy and molecular diagnostictest such as NAAT.

Results Among 57,174 individuals tested, 6,052 were confirmed as newlydiagnosedTB cases. The TB incidence rate across the districts averaged 1,865 per 100,000 individuals, with the 95% confidence interval ranging from 1,818 to 1,911.

Conclusions The study highlights a critical TB burden among the Saharia tribe. The marked inter-district variation underscores the need for geographically tailored public health strategies. Strengthening early detection, enhancing treatment access and fostering community engagement are essential to reducing TB incidence and improving health outcomes in this marginalized population.

Keywords Tuberculosis (TB), Saharia tribe, Madhya Pradesh, Incidence rate, Public health

1 Background

Tuberculosis (TB) continues to be a significant public health concern in India, particularly among marginalized and socioeconomically disadvantaged populations. Prior to the COVID-19 pandemic, TB was the leading cause of death from a single infectious agent globally, surpassing HIV/AIDS.In 2020, the South-East Asia region accounted for 43% of global TB cases, with India contributing the highest share at 26% [1]. India also reported 38% of global TB deaths among HIV-negative individuals and 34% of total TB

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deaths, including both HIV-negative and HIV-positive population [1]. According to the Global TB Report 2021, the estimated incidence of all forms of TB in India was 188 per 100,000 population [1]. The National TB Prevalence Survey reported a pulmonary TB prevalence of 316 per 100,000 population nationally, with Madhya Pradesh showing a slightly higher prevalence of 386 per 100,000 [2]. Among tribal populations, the burden is even more pronounced. A nationwide study reported a TB prevalence of 432 per 100,000 among tribal communities, significantly higher than the general population [3].

In Madhya Pradesh, the Saharia tribe, a Particularly Vulnerable Tribal Group (PVTG), has been identified as bearing a disproportionately high TB burden. A study conducted in Gwalior district reported a prevalence of 3,294 per 100,000 among the Saharia community [4]. Despite the long-standing efforts of the National TB Elimination Programme (NTEP), TB continues to pose a major challenge in this population due to structural barriers such as poor healthcare access, geographic isolation and socioeconomic vulnerabilities [5, 6]. The Saharia community typically resides in small clusters of hamlets, often referred to as '*Saharana*', situated adjacent to larger villages. This population experiences significant socioeconomic disadvantage, characterized by high rates of poverty, substandard housing and overcrowded living conditions. These factors contribute to poor nutritional status among community members. The primary livelihoods for the majority of the Saharia people involve daily wage labor, particularly in agricultural settings, often necessitating seasonal migration in search of employment opportunities [7, 8].

To address the persistent challenges of TB prevalence in tribal population, the Indian Council of Medical Research (ICMR), National Institute of Research in Tribal Health (ICMR-NIRTH), in partnership with the Government of Madhya Pradesh, initiated a comprehensive intervention study from 2018 to 2021. The primary objective of this study was to enhance TB case detection and improve treatment outcomes employing communitybased strategies specifically designed for the Saharia tribal population [9]. This article presents one of the key findings from the study, the districtwise incidence of TB resulting from the intervention.

2 Methods

2.1 Study area and population

A communitybased cross-sectional study was conducted from December 2018 to March 2021 across seven districts in Gwalior and Chambal division of Madhya Pradesh i.e., Sheopur, Morena, Bhind, Gwalior, Shivpuri, Ashoknagar, and Datia, [Fig. 1] selected due to their high concentration of the Saharia tribal population. These districts were identified using demographic data indicating a significant presence of PVTGs.

2.2 Population screening and case identification

A two-tiered screening approach was adopted to improve TB case detection. In the initial phase, trained community health workers and volunteers conducted fortnightly door-to-door surveys using a structured questionnaire to identify individuals with symptoms suggestive of TB, including a persistent cough lasting two weeks or more, fever, unexplained weight loss and hemoptysis. Individuals meeting the criteria for presumptive TB were referred for diagnostic evaluation. In the second phase, diagnostic confirmation involved sputum smear microscopy and molecular testing. Two sputum samples (spot and early morning) were collected and examined using Ziehl-Neelsen staining to

Fig. 1 **a** Madhya Pradesh state in India. **b** Location of study districts in Madhya Pradesh state

Table 1 Distribution of New TB Cases by Diagnostic Method (*N* = 6,052)

Diagnostic Category	Number (*n*)	Percentage (%)
Total Cases Detected	7312	100
New TB Cases Detected	6052	82.8
Diagnostic Methods (N = 7,312)		
Microscopy Positive	1033	14.1
CBNAAT Positive	6101	83.4
TrueNAT Positive	199	2.7
Total Molecular Positive (CBNAAT + TrueNAT)	6300	86.2
Microscopy + Molecular Both Positive	516	7.1
Resistance Detection		
CBNAAT Rifampicin Resistant Detected	22	0.3
TrueNAT Rifampicin Resistant Detected	0	0
Total Rifampicin Resistant (CBNAAT + TrueNAT)	22	0.3

detect acid-fast bacilli. Molecular testing was performed using Cartridge-Based Nucleic Acid Amplification Test (CBNAAT) or TrueNat platforms at the nearest testing centre available under the program Table 1. A case was classified as bacteriologically confirmed if *Mycobacterium tuberculosis* was detected by either microscopy or molecular testing.

2.3 Data collection and analysis

Data were captured using a customized application developed in CSPro version 5.0, incorporating logical checks and conditional rules to minimize data entry errors. Statistical analysis was conducted using IBM SPSS Statistics version 20.0.

2.4 Tuberculosis incidence

The incidence of pulmonary TB was calculated per 100,000 population, with 95% confidence intervals. TB incidence was defined as the number of newly diagnosed bacteriologically confirmed cases during the study period (December 2018 to March 2021), standardized per 100,000 population.

2.5 Ethical approval and consent to participate

The study protocol received ethical clearance from the Institutional Ethics Committee (IEC) of the ICMR–NIRTH, Jabalpur. Prior to participation, trained field investigators

and community volunteers approached eligible individuals and provided detailed information about the study objectives, procedures, potential risks and benefits in the local language to ensure comprehension. Written informed consent was obtained from all participants who agreed to take part in the study. Participation was entirely voluntary and individuals retained the right to withdraw from the study at any stage without any consequences.

3 Results

3.1 Study coverage and population screening

The intervention was carried out across seven districts in Madhya Pradesh, targeting areas with a high concentration of the Saharia tribal population. A total of 1,814 villages and 120,896 households were covered. The screening included 324,474 individuals aged 15 years and above. Of these, 57,174 individuals (17.6%) were identified as presumptive TB cases based on symptom screening and were referred for diagnostic testing.

3.2 TB case detection and incidence

Among the 57,174 individuals tested, the TB was diagnosed in 7,312 cases, of which 6,052 were newly identified bacteriologically confirmed cases. The overall TB incidence across the study population was estimated at 1,865 per 100,000 population (95% CI: 1,818–1,911). [Table 2]

3.3 District-wise TB incidence

There was considerable variation in TB incidence across the seven surveyed districts. Bhind reported the highest incidence rate at 2,769 cases per 100,000 population (95% CI: 1,507–4,030), despite the limited coverage of only nine villages. Morena followed with an incidence of 2,461 per 100,000 (95% CI: 2,093–2,828), while Gwalior recorded 2,021 cases per 100,000 (95% CI: 1,867–2,175). Among the districts with the largest screened population, Sheopur and Shivpuri reported incidence rates of 2,107 (95% CI: 2,016–2,197) and 1,863 (95% CI: 1,790–1,936) per 100,000, respectively. In contrast, Ashoknagar and Datia exhibited comparatively lower incidence rates of 1,279 (95% CI:

Table 2 District-wise analysis of tuberculosis incidence among the Saharia population

Districts	Total villages covered	Total Saharia household covered	Total adult population (≥ 15 Yrs.) screened	Total TB presumptive tested	Total TB case detected	Total new TB case	TB incidence per 100,000 population	95% CI
Shivpuri	698	53,769	131,720	20,351	2997	2454	1863	1790–1936
Sheopur	355	32,157	97,437	18,895	2332	2053	2107	2016–2197
Ashoknagar	446	20,249	49,890	6154	794	638	1279	1180–1377
Gwalior	196	9540	31,958	8265	855	646	2021	1867–2175
Datia	70	2411	5993	1832	117	75	1251	970–1532
Bhind	9	294	650	241	25	18	2769	1507–4030
Morena	40	2476	6826	1436	192	168	2461	2093–2828
Total	1814	120,896	324,474	57,174	7312	6052	1865	1818–1911

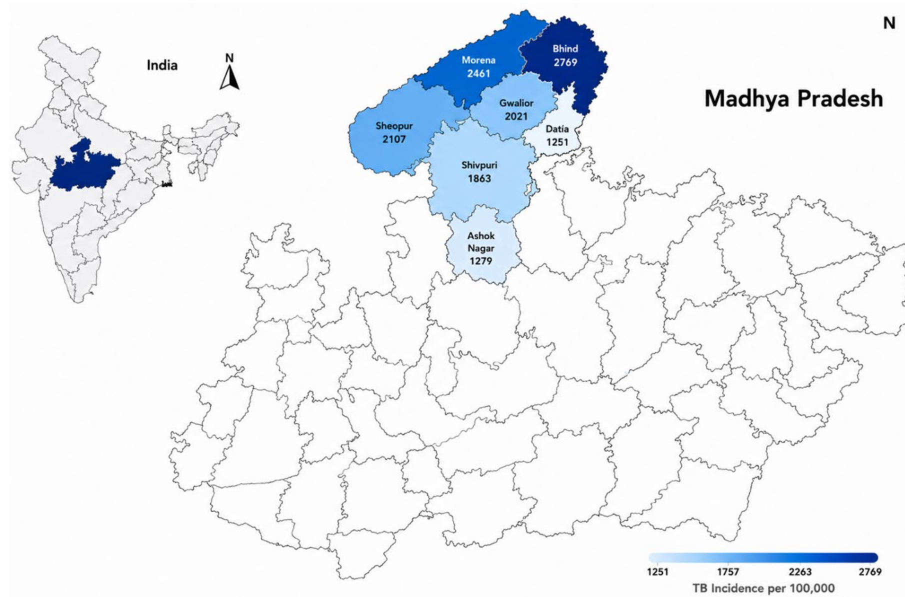

Fig. 2 **a** Madhya Pradesh state in India **b** Incidence of TB in the study districts

1,180–1,377) and 1,251 (95% CI: 970–1,532) per 100,000, respectively. These findings reflect significant geographic disparities in TB burden within the Saharia tribal population [Figure 2; Table 2].

4 Discussion

This study represents the first comprehensive investigation of TB incidence among the Saharia tribe, encompassing all Sahariadominant districts in Madhya Pradesh. Our findings reveal an alarming TB incidence of 1,865 per 100,000 population. This rate is nearly ten times higher than the national average of 188 per 100,000, as reported in the Global TB Report 2021 [1]. This finding is consistent with earlier studies and national surveys that have consistently shown a disproportionately high TB burden among tribal communities [2].

The Saharia tribe, classified as a PVTG, has long been recognized for its high TB burden. A previous study in Shivpuri district, Madhya Pradesh reported a TB incidence of 1504 per 100,000 among the Saharia population [10], which aligns with the high incidence rates observed in the current study.This pattern is not unique to Madhya Pradesh. In Odisha, a study among the Dongria Kondh tribe reported a TB prevalence of 2,100 per 100,000, while the Juang tribe showed a prevalence of 1,200 per 100,000 [11]. The Baiga tribe exhibited a TB prevalence of 1,800 per 100,000 [12] and in Maharashtra, the Katkari tribe showed a prevalence of 1,500 per 100,000 [13]. In Jharkhand, the Birhor tribereported prevalence rates ranging from 800 to 1400 per 100,000 depending onthe district [14]. These figures, though lower than those observed among the Saharia, still far exceed the national average and highlight the systemic neglect of tribal health needs.The India TB Report 2023 confirms that tribal districts consistently report higher TB notification rates compared to non-tribal districts [15].

The district-wise variation in TB incidence observed in this study reflects the heterogeneity in healthcare access and programmatic implementation across regions. Bhind, despite limited village coverage, reported the highest incidence, suggesting

potential underreporting or undetected cases in previous surveillance efforts. In contrast, Ashoknagar and Datia exhibited lower incidence rates, possibly due to better healthcare outreach or differences in settlement patterns.Such disparities are echoed in other regions. In Jharkhand, a study among the Birhor tribe found that TB prevalence varied significantly between districts, with Latehar reporting 1,400 per 100,000 and Simdega only 800 per 100,000. [12, 14–15] These differences underscore the need for localized epidemiological assessments and tailored interventions.

The two-tiered screening approach adopted in this study, combining symptombased surveys with molecular diagnostics, proved effective in identifying a large number of bacteriologically confirmed TB cases. The use of CBNAAT and TrueNat platforms enhanced diagnostic accuracy and enabled the detection of rifampicin resistance, facilitating timely initiation of appropriate treatment regimens.Communitybased strategies have been increasingly recognized as essential for TB control in hard-to-reach population. The Tribal TB initiative, launched in 2021 by the Ministry of Tribal Affairs and the Ministry of Health and Family Welfare, emphasized the role of community engagement in bridging diagnostic and treatment gaps [16]. A pilot project in Jharkhand involving ASHAs and tribal health volunteers demonstrated a 40% increase in TB case notifications within one year [15]. Similarly, in Odisha, mobile diagnostic vans equipped with digital X-ray and CBNAAT machines were deployed in tribal blocks, resulting in a 30% increase in case detection [17]. These interventions mirror the success of the current study, which screened over 324,000 individuals and identified more than 6,000 new TB cases. The persistently high TB burden among the Saharia tribe cannot be fully understood without addressing the underlying social determinants of health. Poverty, food insecurity and inadequate housing create an environment conducive to TB transmission and progression. Malnutrition, in particular, is a significant risk factor [18]. According to the Swasthya portal, over 60% of tribal children under five are undernourished and adult undernutrition is widespread [19].

Geographic isolation and limited transportation infrastructure further hinder access to diagnostic and treatment facilities. In many tribal areas, health centers are located several kilometers away, and the lack of public transport exacerbates the problem. These barriers contribute to diagnostic delays, increased transmission and higher mortality rates. Addressing these structural barriers requires a multi-sectoral approach that integrates health services with social protection schemes, nutritional support and livelihood programs. The Nikshay Poshan Yojana, which provides nutritional support to TB patients, is a step in the right direction, but its implementation needs to be strengthened in tribal areas to ensure timely and adequate disbursement of benefits [7]. The findings from this study have significant implications for the NTEP, which aims to eliminate TB in India. While the program has made commendable progress in expanding diagnostic and treatment services, tribal population continue to be underserved. The programs in the study districts continue to remain robust; however, no special program's provisions are available in these districts, as they have not been classified as tribal districts. The high TB incidence among the Saharia tribe indicates that current strategies may not be adequately reaching the most vulnerable groups. To achieve the ambitious elimination targets, the NTEP must prioritize tribal regions through dedicated sub-programs that address the unique challenges faced by these communities. This includes deploying

mobile diagnostic units, strengthening community health worker networks and integrating TB services with other tribal health initiatives.

In conclusion, this study reaffirms the disproportionately high burden of TB among the Saharia tribe in Madhya Pradesh. When compared with similar studies across India, from Odisha to Jharkhand and Maharashtra, it is evident that tribal population consistently face higher TB burdens due to structural and systemic inequities. The high incidence underlines the need for interventional strategies to reduce the TB burden. One such strategy of active screening using community volunteers was tested in the study which had an impact on the prevalence of TB in the area [9]. NTEP has also evolved fortackling the disease burden in the area. However, as India strives toward TB elimination, prioritizing the health needs of its most marginalized communities is not only a matter of equity but also a strategic imperative for national success. The dream of TB free India will be achieved only when the goals are achieved for all populations.

4.1 Limitation of the study

In the current study, the findings were derived solely from symptom screeningto patients aged > 15 years, potentially underestimating the pediatric disease burden and the lack of a mobile X-ray unit precluded the performance of chest radiography, which may have led to an underestimation of the true incidence of TB within this indigenous community. Nevertheless, the results suggest a high incidence of TB among this population, which may serve as an important indicator for monitoring the epidemiological status of TB in this demographic group. Sputum samples were analyzed using both smear microscopy and nucleic acid amplification tests (NAAT) in the present study.

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Author contributions

RKS, RY, MM, VGR & JB contributed to the concept, design and implementation of the study. They also drafted and revised the manuscript. PM, SN, and MAL contributed to the study's execution, collection of data, and monitoring. RKS and JB have verified the data. PM, MM &RKS analyzed the data. PM, JB, MM drafted the manuscript. JB, RKS, MM, VGR and RY decided to submit the manuscript.

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Data availability

The data supporting the results is available on request.

Declarations

Ethics approval and consent to participate

The Institutional Ethics Committee of ICMR-NIRTH, Jabalpur approved the study (NIRTH/IEC/2273/2016). Informed written consent was taken from all the participants in the study. The study was conducted in compliance with National Ethical Guidelines for Biomedical and Human Research involving Human Participants 2017 (Indian Council of Medical Research, New Delhi).

Competing interests

The authors declare no competing interests.

Consent to participate

Not applicable.

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