

# Persistent high prevalence of pulmonary tuberculosis in a resource-limited setting: threat to India's TB Free campaign

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**Background:** Tuberculosis (TB) is a major public health problem among Saharia, a particularly vulnerable tribal group residing in remote rural areas in central India. This article presents the findings from the baseline survey among Saharias and provides comprehensive prevalence data of pulmonary TB (PTB) in this marginalised community.

**Methods:** A community-based cross-sectional PTB prevalence survey was carried out during January–May 2019 in selected villages using multistage stratified cluster sampling. All eligible adults ( $\geq 15$  years of age) were screened for the symptoms of PTB. Sputum samples were collected and processed for microscopy and culture for *Mycobacterium tuberculosis*.

**Results:** A total of 20 114 eligible individuals were screened for symptoms of PTB. Among these, 3001 (14.9%) individuals reported at least one PTB symptom and sputum was collected from 2890 (96.3%) individuals. Among these, 273 (9.4%) were bacteriologically positive for PTB. The overall prevalence was 1357 per 100 000 population.

**Conclusions:** The findings indicate that TB continues to be a major health problem in this marginalised community despite large investments by the government for TB control. This emphasizes the need to look into the causes and barriers in implementation of the TB elimination programme in the community, especially in view of India's TB elimination goal by 2025.

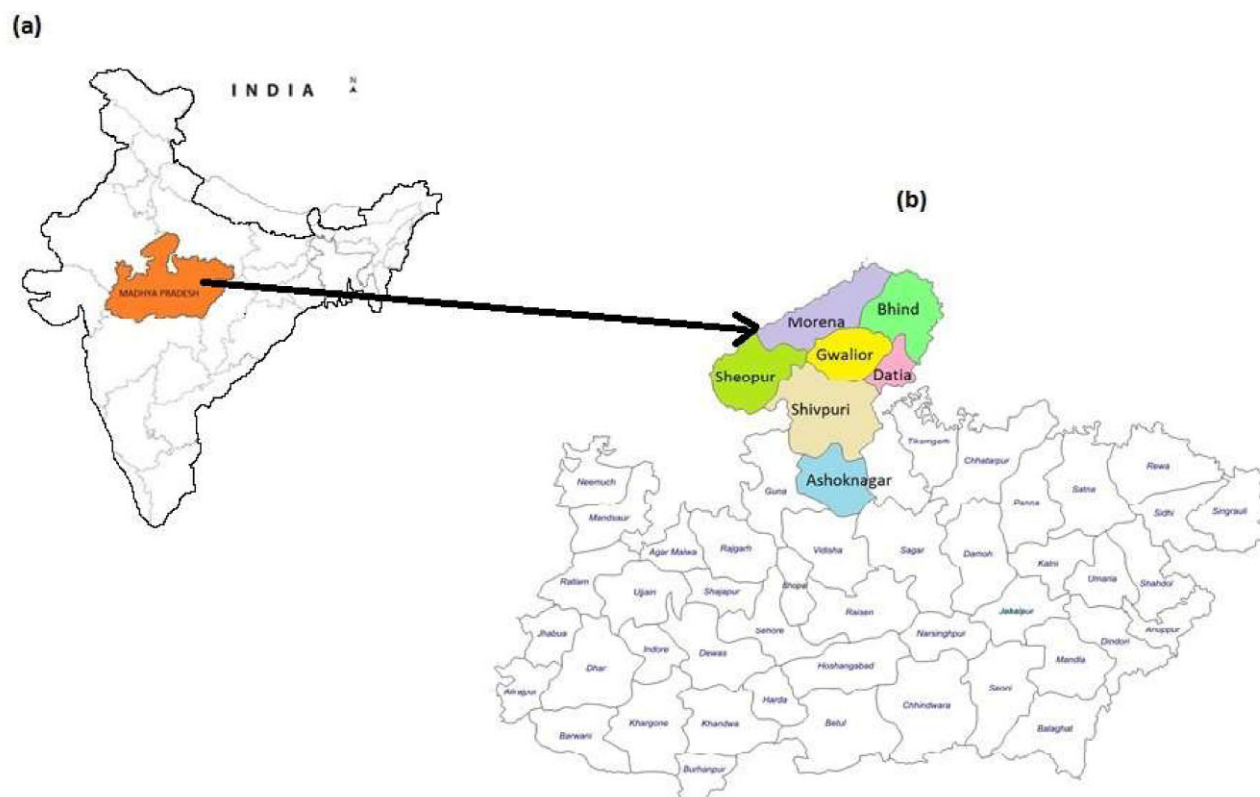
**Keywords:** India, prevalence, tuberculosis, vulnerable population

## Introduction

Tuberculosis (TB) is one of the leading global health problems and affects up to 10 million people every year.<sup>1</sup> Almost one-fourth of the world's population is infected with *Mycobacterium tuberculosis* and are at risk of developing TB disease.<sup>2</sup> Although the disease occurs globally, most TB cases in 2018 were recorded in the regions of Southeast Asia (44%), Africa (24%) and the Western Pacific (18%). To address this challenge, the World Health Organization adopted the End TB strategy, with targets to reduce the incidence of TB by 90% and deaths by 95% by 2035 compared with 2015 levels.<sup>3</sup>

In India, the disease continues to be a serious public health challenge despite successful implementation of the National Tuberculosis Elimination Programme (NTEP) throughout the country. India alone contributed 27% of global TB cases and

had the highest global burden of drug-resistant TB (27%).<sup>1</sup> With the directly observed treatment, short-course (DOTS) strategy, the quality of diagnosis and treatment outcomes have improved substantially. Recent evidence indicates that the TB burden is decreasing, but at a slow pace.<sup>4</sup> In India, the TB burden and its trends vary widely in different geographic regions.<sup>5</sup> The Madhya Pradesh state in central India contributes about 7% of India's total TB cases. In the year 2019, 142 986 cases were notified, with a success rate of 83% and a loss to follow-up of 3.5%.<sup>6</sup> Within the state, very high TB prevalence has been reported among Saharia, a particularly vulnerable tribal group (PVTG) of Madhya Pradesh state. The studies carried out in selected geographical areas reported a very high pulmonary TB (PTB) prevalence of 1270 in 1991–1992,<sup>7</sup> 1518 in 2008<sup>8</sup> and 3294 in 2012–2013<sup>9</sup> per 100 000 in this community. The NTEP has a special tribal action plan addressing specific issues, especially



**Figure 1.** Map showing the location of the study area.

accessibility and acceptability of TB services in the remote, hilly tribal areas, and makes provisions for decentralization of diagnostic and treatment services with additional incentives to the staff.<sup>10</sup> The programme performance in the area has shown gradual improvement since implementation of the NTEP. A TB control intervention study carried out in a defined geographical area recently recorded a decline in TB prevalence in the community.<sup>11</sup> But even after the decline, the prevalence of PTB remains extremely high, which is a matter of concern.<sup>12</sup>

The disproportionate burden of TB in various population groups, especially marginalised populations, is a serious threat to India's TB elimination goal of ending TB by 2025. In view of this, the Indian Council of Medical Research (ICMR)–National Institute of Research in Tribal Health (NIRTH), in collaboration with the government to Madhya Pradesh, has taken up a study 'Intensified Tuberculosis Control among Saharia Tribe of Madhya Pradesh' in 2018–2019 to reduce the prevalence of TB through active case detection and compliance with treatment involving local volunteers. This article presents the findings of the baseline prevalence survey conducted among the Saharia community in this resource-limited setting.

## Methods

### Study area and population

The state of Madhya Pradesh, in central India, has the largest tribal population in the country. About one-fifth of the state's

population is classified as a scheduled tribe as per the 2011 census. Of the 46 identified tribes in the state, three tribes, the Bharia, Baiga and Saharia, are classified as PVTGs.<sup>13</sup> Among these, the Saharia, also known as Sahar, Sehariya or Sahariya, has the poorest socio-economic indicators.<sup>14</sup> The major economy of the tribe is agriculture, although the majority earn their livelihood as agricultural labourers. They mainly reside outside the main village and their hamlets/clusters of houses are called *saharana*.<sup>14</sup> This population continues to lack access to education and health facilities, are financially constrained and have risk factor behaviours such as tobacco smoking and alcohol consumption.<sup>15</sup>

The Saharia tribe mainly resides in seven districts of the Gwalior and Chambal divisions of Madhya Pradesh (Morena, Sheopur, Bhind, Gwalior, Datia, Shivpuri and Ashok Nagar). The present baseline survey was carried out in selected villages from these districts (Figure 1).

### Sample size

The earlier studies carried out among the Saharia tribe in selected geographical areas showed that the prevalence of bacteriologically positive TB varies from 1500 to 3000 per 100 000 adult population. Thus, assuming a prevalence of PTB of 1500/100 000 (the lowest recorded PTB in the Saharia tribe), at a 95% confidence level, 20% relative precision and design effect of 3, the minimum desired sample was 19 700 adults ( $\geq 15$  years of age). Further, to have coverage of at least 90%, the estimated sample size was 21 889–21 900 adults.

## Sampling

Since the study was planned to be carried out in Saharia villages in seven districts, the estimated sample size was distributed among districts proportionally to each district's Saharia population. Further, within a district the sample size was distributed proportionally to the Saharia population among different development blocks. The required number of villages was selected through the probability proportional to size (PPS) sampling technique from all blocks in proportion to the size of the Saharia population within a district. In selected villages, only *saharana* hamlets were included in the survey. All households (including non-Saharia households, if any) in *saharana* hamlets were included in the survey. All available eligible adults ( $\geq 15$  years of age) in the household were screened for the symptoms of PTB.

## Census and registration

A cross-sectional PTB prevalence survey was carried out during January–May 2019. The survey team visited all selected villages/*saharana* before the disease survey and organized group meetings, including village leaders, tribal community heads and other members, to explain the aim and objectives of the study. In selected villages/*saharana*, house-to-house complete enumeration was carried out and all individuals  $\geq 15$  years of age available in the household at the time of the survey were registered. The individuals who remained absent during three consecutive visits were excluded from the survey. Individuals who were not usual residents of the household and those who refused to participate in the study or to provide written consent were also excluded. The information was collected on a precoded and pretested individual TB card.

## Screening, sputum collection and examination

All *saharana* dwellers  $\geq 15$  years of age were asked about the symptoms of PTB, including cough for  $\geq 2$  weeks, chest pain for  $\geq 1$  month, fever for  $\geq 1$  month and haemoptysis in the last 6 months. All the presumptive PTB cases, along with persons with a history of previous anti-TB treatment, were considered eligible for sputum collection. One spot and one overnight sputum sample were collected in sterile containers from eligible individuals. The samples collected from the field were transported to the ICMR–NIRTH laboratory, maintaining the cold chain. The samples were processed using the N-acetyl-L-cysteine sodium hydroxide method. Smears were made and stained with auramine O for fluorescent microscopy. The deposit from the processed specimens was inoculated on Lowenstein–Jensen medium and the growth of *M. tuberculosis* was recorded weekly for 8 weeks and confirmed by an MPT64-based rapid diagnostic kit (SD Bioline, Yongin, Republic of Korea). Drug susceptibility testing was done for positive individuals as per the guidelines of the NTEP.

## Case definition and treatment

An individual was considered as a case of PTB if any of the two sputum samples tested positive for acid-fast bacilli (AFB) by microscopy and/or culture examination. All the cases were given

anti-TB treatment under the NTEP using standardized treatment regimens.<sup>5</sup>

## Data entry and statistical analysis

The TB cards collected in the field were checked for missing information and further checked in the office for inconsistencies. All TB cards were entered twice by two data entry operators in the data entry software in CSPro 7.0. Study investigators periodically compared both copies of data and data entry inconsistencies were removed after verifying the TB cards and consulting the field teams. The univariate and bivariate tables were generated from the raw data using SPSS version 26 software (IBM, Armonk, NY, USA). The  $2 \times 2$   $\chi^2$  test,  $\chi^2$  test for linear trend and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to aggregate data by using OpenEpi ([www.openepi.com](http://www.openepi.com)).

## Ethical clearance

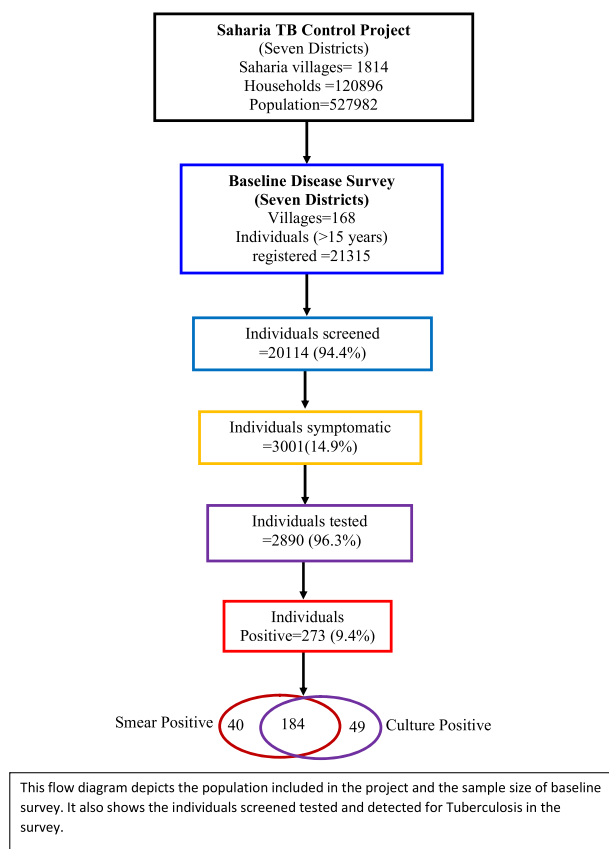
The study was carried out as a baseline survey of the ongoing main study 'Intensified Tuberculosis Control among Saharia Tribe of Madhya Pradesh'. The Institutional Ethical Committee of ICMR–NIRTH, Jabalpur approved the study (reference NIRTH/IEC/2273/2016). Written consent was obtained from all individuals screened for TB symptoms.

## Results

Out of 1814 Saharia-dominated villages/*saharana* in seven districts, 168 villages were selected for the disease survey. In selected villages, a total of 21 315 individuals  $\geq 15$  years of age were registered during the baseline survey. Of these, 20 114 (94.4%) individuals were screened for symptoms of PTB (Figure 2). Among screened individuals, 19 620 (97.5%) were from the Saharia tribe and the remaining 494 (2.5%) belonged to other tribes or non-tribal communities. Among the individuals who were screened for PTB, 11.3% reported having a cough for  $> 2$  weeks and 4.8% and 1.1% of individuals reported chest pain and fever for  $> 1$  month, respectively. Haemoptysis during the last 6 months was reported by 2.5% of screened individuals and 0.9% reported a history of anti-TB treatment. Overall, 3001 (14.9%) individuals reported at least one symptom and sputum was collected from 2890 (96.3%) individuals. The coverage of screening for symptoms and sputum collection was  $> 95\%$  (Figure 2). Overall, the screened population ranged from 94 in Bhand to 8267 individuals in Shivpuri district and the proportion of presumptive PTB cases ranged from 9% in Datia to 17% in Sheopur district (Table 1). The presumptive cases also increased with age, from 5.4% in the 15–24 y age group to 27.0% in the  $\geq 55$  y age group ( $\chi^2$  for linear trend=982.3,  $p < 0.001$ ). The proportion of presumptive PTB cases was considerably more among males (20.8%) than females (9.0%) ( $p < 0.001$ ) (Table 2).

## Prevalence of PTB

Of 2890 individuals tested for PTB, 273 (9.4%) were bacteriologically positive for PTB and, among these, 184 were both smear and culture positive, 40 were only smear positive and 49 were only culture positive (Figure 2). The positivity among samples tested ranged from 8% in Ashok Nagar to 20.4% in Morena district. The



**Figure 2.** Flow diagram showing villages, population selected and individuals testing positive for PTB.

PTB prevalence was 1357 per 100 000 in the study population and ranged from 912 in Datia to 2857 per 100 000 individuals in Morena district (Table 1). Males had a significantly higher (2170/100 000) prevalence of PTB than females (546/100 000) OR=4.04; 95% CI: 3.02 to 5.48;  $p < 0.001$  (Table 2). The prevalence of PTB increased significantly with age, from 511/100 000 in the 15–24 y age group to 2637/100 000 in the 44–54 y age group ( $\chi^2$  for linear trend=66.0,  $p < 0.001$ ). The individuals in the age group 45–54 y were five times OR=5.27; 95% CI: 3.44 to 8.20;  $p < 0.001$  more likely to have PTB than individuals in the 15–24 y age group (Table 2). The increasing trend in the prevalence of PTB by age was more prominent among males compared with females. Among males, the prevalence of PTB increased significantly from 541/100 000 in the 15–24 y age group to 4380/100 000 in the 45–54 y age group ( $\chi^2$  for linear trend=80.6,  $p < 0.001$ ), while in females it increased from 483/100 000 in the 15–24 y age group to 904/100 000 in the 45–54 y age group (Figure 3). The prevalence of PTB among Saharias (1376/100 000) was more than two times higher compared with that in non-Saharias (607/100 000) residing in the same villages (Table 2), but the difference was not statistically significant.

## Discussion

TB remains a leading health problem and globally millions of persons suffer from TB every year.<sup>1</sup> TB and multidrug-resistant

TB (MDR-TB) are disproportionately high in India and the government of India has set an ambitious target of TB elimination by the year 2025.<sup>5</sup> India's National Strategic Plan (2017–25) provides strategies for TB elimination in the country by 2025. It aims to reduce TB prevalence from 320/100 000 in 2015 to 65/100 000 in 2025. It also emphasizes the need for specific activity to aggressively control TB in disadvantaged population groups, including the tribal population.<sup>5</sup> The tribal population numbered 104.28 million in the 2011 census, constituting 8.6% of the country's total population. Although India has successfully scaled up TB services in general, the situation in tribal areas needs special attention.

Many studies have documented an alarmingly high prevalence of PTB in Saharia PVTGs of Madhya Pradesh. However, all earlier studies were conducted in defined small geographical areas (a block or a district) and hence the findings did not apply to the total Saharia population in the state. Because of this, the present study was undertaken in all seven districts of Madhya Pradesh to provide a comprehensive prevalence of PTB in this ethnic group. The present study recorded the prevalence of PTB as 1357/100 000 population, which is reprehensibly high. Earlier studies carried out among the Saharia tribe reported a very high PTB prevalence of 1270 in the year 1991–1992<sup>7</sup> and 1518 in 2008<sup>8</sup> in the Karhal block of Sheopur district and 3294 in Gwalior district in the year 2012–2013<sup>9</sup> per 100 000 population. The prevalence of TB infection and the annual risk of TB infection were reported as 20.4% and 3.9%, respectively.<sup>16</sup> Our study reports relatively lower PTB prevalence compared with the findings of Rao et al.<sup>9</sup> A recent intervention study carried out in selected villages of Shivpuri district has also recorded a decline in TB prevalence in the community.<sup>11</sup> Despite the decreasing prevalence, the present study indicates that TB is still a major health problem among the Saharia tribe of Madhya Pradesh, as also mentioned by Bhat et al.<sup>12</sup>

The present study recorded a higher prevalence among Saharias compared with non-Saharias residing in the same villages. However, these results need to be carefully interpreted as only a few non-Saharia individuals were available for screening. The higher burden of TB among indigenous people compared with the non-indigenous population is thoroughly documented.<sup>17</sup> The TB prevalence among Saharia is the highest reported among different tribal communities in the country and varies substantially, ranging from 133/100 000 among the tribal population in Wardha district, Maharashtra region<sup>18</sup> to 3294/100 000 among the Saharia PTVG of Gwalior district in Madhya Pradesh.<sup>9</sup> However, there are only a few TB surveys that have been carried out in tribal communities in India and these are mostly from central India.<sup>7–9</sup> Therefore the recent systematic reviews have highlighted the need for more research on TB burden and control measures in tribal areas.<sup>19,20</sup>

The study findings of increasing prevalence with age and in males are consistent with the global trend<sup>1</sup> and findings of other studies.<sup>21,22</sup> Earlier studies carried out among tribal populations also reported similar findings.<sup>7–9,23</sup> Elderly patients are at higher risk because of a higher chance of loss to follow-up, complications and other comorbid conditions.<sup>24</sup> The biological differences in their susceptibility to TB could also be a reason for the difference observed in the PTB prevalence between men and women.<sup>25</sup> However, differences in healthcare-seeking behaviour,<sup>26</sup> access

**Table 1.** Prevalence of PTB in seven Saharia districts of Madhya Pradesh

Districts	Individuals eligible for screening, n	Screened population, n	Symptomatic individuals, n	Sputum samples collected, n	Sputum positive, n	Prevalence (positive/screened population) per 100 000
Ashoknagar	3692	3314	536	522	42	1267 (915/1709)
Bhind	107	94	21	20	3	3191 (662/9044)
Datia	563	548	48	45	5	912 (297/2116)
Gwalior	1899	1708	261	243	33	1932 (1333/2703)
Morena	416	385	54	54	11	2857 (1435/5054)
Sheopur	6032	5698	973	955	78	1369 (1084/1706)
Shivpuri	8606	8367	1108	1051	101	1207 (984/1465)
Total	21315	20114	3001	2890	273	1357 (1202/1527)

**Table 2.** Prevalence of PTB by selected characteristics of Saharia tribe in Madhya Pradesh

Background characteristics	Individuals eligible for screening, n	Screened population, n	Symptomatic individuals, n	Samples collected, n	Sputum positive, n	Prevalence (positive/screened population) per 100 000 <sup>a</sup>	OR (95% CI) <sup>b</sup>
Age groups							
15–24	6587	6062	330	299	31	511 (348/725)	1
25–34	5593	5290	644	610	56	1059 (800/1372)	2.08 (1.34 to 3.27)**
35–44	3768	3589	690	674	67	1867 (1450/2365)	3.70 (1.43 to 5.74)**
45–54	2522	2427	596	580	64	2637 (2037/3355)	5.27 (3.44 to 8.20)**
≥55	2845	2746	741	727	55	2003 (1512/2599)	3.98 (2.56 to 6.25)**
Sex							
Male	10 813	10 044	2093	2022	218	2170 (1895/2475)	4.04 (3.02 to 5.48)**
Female	10 502	10 070	908	868	55	546 (411/710)	1
Caste/Tribe							
Saharia	20 720	19620	2923	2812	270	1376 (1218/1549)	2.28 (0.73 to 7.15)
Other	595	494	78	78	3	607 (125/1764)	1
Total	21 315	20 114	3001	2890	273	1357 (1202/1527)	

<sup>a</sup>Prevalence (positive cases per 100 000 population screened).

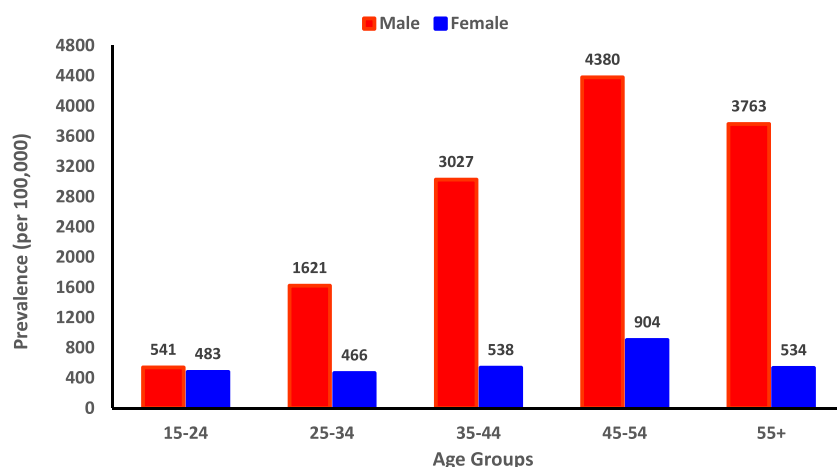
<sup>b</sup>OR (odds of positive cases among screened cases in a category compared with that in the reference category).

\*\*p<0.01.

to healthcare services,<sup>27</sup> smoking,<sup>14,28</sup> alcohol use<sup>14</sup> and exposure to indoor dusts and air pollution<sup>28</sup> could be associated with the observed gender inequality in TB prevalence. Most of the female patients were young and in the reproductive age group, which could have consequences for reproductive health and outcomes. The higher chances of mother-to-child transmission and higher probability of complications due to antenatal and postnatal morbidity may also influence the strategies adopted for TB control.<sup>24</sup>

The higher burden of TB disease in Saharia PVTGs should be interpreted in the light of the estimated prevalence of 320/100 000 population in the country<sup>5</sup> and the 387/100 000 in the tribal population of Madhya Pradesh.<sup>21</sup> In spite of large investments by the government for TB control in this resource-limited

setting and implementation of the NTEP for the last 15 y, this persistent high burden can hinder the goals of TB elimination in the country and special efforts are needed to control TB in this marginalized population. India is committed to the overall development of the tribal population and among these, PVTGs are the most vulnerable tribal groups. Recently the NTEP, in collaboration with the Ministry of Tribal Affairs, launched the Tribal TB initiative to improve TB care and support services among tribal populations in the country. The major activities under the initiative include vulnerability mapping, active case finding, sensitization and capacity building of volunteers and isoniazid preventive therapy to identify vulnerable populations. Bringing together multiple stakeholders, it also aims at strengthening governance, financing, supply chains and infrastructure.<sup>29</sup> The Saharia, one of the



**Figure 3.** Prevalence of PTB by age and gender.

PVTGs in the country, although small in number, requires more focus and special efforts to reduce the alarmingly high TB burden in this community and to achieve the goal of a TB-free India by 2025. The NTEP has now implemented upfront molecular testing for this population, but it may not be sufficient to reduce the high transmission in this community. These efforts should be aided by active case detection using mobile X-ray units, followed by monitoring of treatment adherence to minimize transmission. Advocacy, communication and social mobilisation will also aid in the long-term sustainability of the impacts by ensuring active community participation. Socio-anthropological research may be helpful in understanding sociocultural factors and in designing appropriate interventions in this tribal group.

## Limitations

Although due care was taken throughout the study to provide a valid estimate of PTB among Saharia PVTGs, the results of the study need to be interpreted with care. The findings are based on symptoms elicitation without chest X-rays. This may have resulted in an underestimation of the true prevalence in this population. As the survey was carried out among adults ( $\geq 15$  years of age), no information on childhood TB or extrapulmonary TB could be collected.

## Conclusions

The persistent high prevalence of PTB in the community despite implementation of the NTEP in these areas since 2004 highlights the need for further improvement and strengthening of TB control activities. Further studies are required to look into the causes and barriers in the implementation of the TB elimination programme in the community. Persistent high prevalence in this resource-limited setting is a challenge that needs to be tackled to achieve India's TB elimination goal by 2025.

**Author's contributions:** RKS, RY, VGR and JB are investigators in the ongoing Intensified Tuberculosis Control among Saharia Tribe of Madhya

Pradesh intervention study and contributed to the concept and design of the study and drafting and revision of the manuscript. PM, SN and MAL contributed to data collection and monitoring. All the authors have read and edited the manuscript.

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**Competing interests:** None declared.

**Ethical approval:** The study was carried out as a baseline survey of the ongoing main study Intensified Tuberculosis Control among Saharia Tribe of Madhya Pradesh. The Institutional Ethical Committee of the ICMR-NIRTH, Jabalpur approved the study (reference NIRTH/IEC/2273/2016). Written informed consent was obtained from all individuals screened for TB symptoms.

**Data availability statement:** RKS and JB have full access to the data and take responsibility for the integrity and accuracy of the results. The data used in the present study are part of an ongoing intervention study and include information on personal identification, lifestyle and disease, thus

the data are not available in the public domain but are available on reasonable request.

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