Original Article

A study to assess the prevalence of Tuberculosis to review "TB free status" in Nashik district, Maharashtra, India

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Abstract

Tuberculosis (TB) is an infectious disease that is a significant cause of ill health and one of the leading causes of death worldwide. The prevalence of tuberculosis varies significantly across the country. Recent sub-national surveys have revealed wide geographical variation and discordance with corresponding annual notification rates. Present study aimed to estimate the prevalence of TB in 2022 to review the TB-free status of Nashik Districts. **Methods:** We conducted community-based cross-sectional household survey between Jan 2021- March 2021. The district was divided into 15 survey units based on the number of TB units. We selected one village/ward from each survey unit using probability proportional to sampling. The estimated sample size was 30 bacteriologically positive TB patients using inverse sampling method. The prevalence of TB in 2020 was estimated by two methods- direct and indirect. Besides, proportionate decline, numbers needed to test and TB score were also estimated. Along with this, the prevalence was also estimated by drug consumption. **Results:** The TB prevalence was estimated as 60, 43 and 40 per 100,000 using direct estimate, indirect estimate, and drug consumption methods, respectively. There was a significant reduction in TB prevalence from the baseline year 2015 to more than 40 percent (62 %, 46%, and 64 % according to indirect estimate, direct estimate, and drug consumption, respectively). **Conclusion**: The study reported reduction of the prevalence of TB in Nashik district in 2020 as compared to 2015. Thus there is need of strategic execution of planned strategies to achieve the goal or TB elimination.

Keywords: Mycobacterium tuberculosis infection, bacterial Infections, pulmonary tuberculosis, TB prevalence

Introduction

Tuberculosis (TB) is an infectious disease that is a significant cause of ill health and one of the leading causes of death worldwide[(1)]. The bacillus *Mycobacterium Tuberculosis* causes TB[(2)]. TB is curable and preventable. In 2019, India reported 2.64 million people infected with TB and approximately 450,000 deaths[(3)]. This indicates that there had been nearly 1000 deaths each day[(3)].

The prevalence of tuberculosis varies significantly across the country, as do the levels of effort put forth in the fight to eliminate the disease[(4)]. Direct estimates of TB prevalence have not been obtained since 1958[(5)]. Recent sub-national surveys have revealed wide geographical variation and discordance with corresponding annual notification rates[(6)]. As a result, it's critical to keep track of progress toward the elimination goal at the subnational level[(7)].

Achieving TB-free status will take longer time and is challenging. In order to appreciate the efforts towards the elimination of TB, the Central TB Division (CTD) has chosen to reward states/districts with monetary and non-monetary rewards based on the percentage reduction in TB prevalence in 2020 compared to 2015[(7)]. The Central TB Division, Government of India, released the guidelines for this activity. The states/districts were only eligible to participate and claim if they met two of three conditions stated as below: (a) districts with a TB score of 80 or higher the prior year; (b) a 20% rise in the Number Needed to Test (NNT) between 2015 and 2020. (c) Compared to 2015, the percentage drop in patient months calculated using anti-TB medicine data (both public and commercial sector) was 20% or more.

Nashik, district, had participated in TB free claims. The present study was designed to determine the prevalence of tuberculosis to review "TB-free status" in Nashik district, Maharashtra, India.

A nationwide prevalence study from 1955 to 1958 yielded direct prevalence estimates for the first time in the nation[(8)]. Subsequently, numerous district and sub-district level studies

used different methodologies and reported a significant difference in prevalence across the country[9]. The study aimed to assess TB prevalence in Nashik district, Maharashtra, and its TB-free status using different estimation techniques. For this purpose, we investigated the prevalence in 2020 and compared it with the prevalence of TB in 2015. We hypothesized that the TB prevalence was lesser than that in 2015.

Material and Methods

Study Design

It was a community based cross-sectional study.

Study settings

This study was done in District Tuberculosis Centre (DTC), Nashik. DTC functioned as the nodal point for all TB control activities under the National Tuberculosis Elimination Program (NTEP) in the district through a Tuberculosis Unit (TU) at the sub-district level.

Sampling procedure

Nashik district was divided into 15 survey units based on the number of TUs (> 10 TUs) representing the entire district in the household survey. We selected one village/ward from each survey unit using probability proportional to size sampling, based on the 2011 census list of villages and wards. Each selected village/ward was considered as a cluster. The sampling unit was the individual residing in the selected village of Nashik district.

Sample size

We used inverse sampling technique to detect a pre-determined number of bacteriologically positive TB patients in the district. Inverse sampling is a technique to estimate a proportion (P) for rare events[5]. In this method, the survey is continued until a pre-determined number of rare events (m) are detected in the surveyed population. The required sample size (n) is not known in advance. Assuming an expected proportion of TB cases as 274 cases/100,000 population and a coefficient of variation of 18.5, sample size was calculated as to detect 30 bacteriologically confirmed TB cases in a district.

Data Collection Procedure

The Institutional Review Board approved all data collection procedures. A written informed consent was obtained from all participants prior to data collection. The survey teams started from a randomly selected household in each cluster and moved sequentially, covering all the households from the selected village/ward. Using an android application developed by the WHO India, the trained survey teams interviewed participants of any gender, and all ages, residing in the selected village/ward for at least one year. Respondents who reported any symptoms (persistent cough for ≥2 weeks, fever for ≥2 weeks, significant weight loss, presence of blood in sputum any time during last six months, chest pain in last one month) or were currently on anti-TB treatment (ATT) or had a history of ATT, were eligible for sputum collection. The sputum was collected and tested in the NTEP center by MTB's rapid molecular test [Cartridge Based Nucleic Acid Amplification Test (CBNAAT) or TrueNAAT). The teams uploaded the results to the application's web page within 24 to 48 hours of collection. It was predefined that the survey would continue until 30 cases of TB were detected in the district or atleast two cases in each cluster. The next geographically adjacent cluster was chosen if the desired number of bacteriologically positive TB patients was not achieved within the selected cluster.

Additional stop rules were pre-decided as follows: i) covering 10,000 households or ii) covering 5% of the total population, whichever was met first. District supervision team conducted field visits during the study to maintain the survey quality.

Data analysis

We used the survey data to calculate the prevalence of TB by both direct and indirect method.

Direct method: The direct method used prevalent MTB cases detected during the survey (those currently on ATT on the date of the survey with a date of diagnosis between March 2020 and March 2021, and those newly testing positive during the survey) as the numerator and total population surveyed as the denominator.

Indirect method: This included verification of the estimates using secondary data. Two different databases were used for this.

Nikshay Database: Data from Nikshay portal was used and compared with the survey data. The prevalent cases (after accounting for underreporting in the Nikshay Database) were divided by the survey population (interviewed for one lakh population) to determine the indirect estimate of prevalence. Underreporting was determined by comparing and validating the cases identified from the survey (with a history of ATT or currently on ATT in the period of 7 March 2020 to 7 March 2021) against the cases notified in the Nikshay at the same time.

$$\text{Indirect Estimate of Incidence} = \left\{ \frac{\text{Incidence cases notified in the year 2020}}{\text{1 - Under reporting}} \right\} \text{ x } 100000$$

Drug consumption data :

Another indirect estimation was based on drug consumption data. The NTEP drug consumption registry provided the information about rifampicin use in the public sector from 2015 to 2020. Data on Rifampicin sales in the private sector was gathered from Clearing and Forwarding (C&F) companies, pharmaceutical companies, distributors,

chemists, drug commissioners, drug inspectors, and independent doctors.

The public drug consumption data was obtained from the drug stock registers from 2015 to 2020 for Nashik district. The public drug consumed in each year was listed, and the patient months were calculated for Rifampicin as an indicator drug.

Patient months was Public sector = Number of Ri drug packs sold in 1 year × Ti
Total patient months in the public sector was calculated using the formula:
Patient months in Public sector = $\sum_i$ [Ni X Ti]

Where Ni - the total number of units (packs/strips/boxes) sold in a year
Ti - the number of treatment months represented by each unit of sale*
*For calculating the Ti, a treatment month was considered 30 days
Total patient months in the private sector was calculated using the formula:
Patient months = $\sum_i$ [Ni(Xi/Ci)(Ti)]
Where Ni - the total number of units (packs/strips/boxes) sold in a year
Ti - the number of treatment months represented by each unit of sale*
Xi – the proportion of sale intended for tuberculosis
Ci – the proportion of sales of the reported drugs
*For calculating the Ti, a treatment month was considered 30 days, the adult dose of rifampicin was 450mg, and the Paediatric dosage 150mg.
Percent decline: Besides the estimates of prevalence rates, percent decline was calculated as

$$\text{Percent decline} = \frac{\text{Rate in 2015} - \text{Rate in 2020}}{\text{Rate in 2015}}$$

Number Needed to Test (NNT): The number needed to test (NNT), being one of the key indicator to determine the change and was considered inverse of test positivity. NNT was calculated for microscopy and molecular tests (CBNAAT/TruenNAAT) combined or separate. NNT increase between 2015 and 2020 was calculated as follows:

$$\text{NNT increase between 2015 and 2020} = \frac{\text{NNT2020- NNT 2015}}{\text{NNT 2015}}$$

TB score: The TB score was calculated from the combined rate of nine diversified parameters namely notification rate, HIV testing rate, drug sensitivity testing rate, treatment success rate, direct benefit transfer rate, drug resistance TB treatment, annual expenditure rate, and rate of children on chemoprophylaxis and TB Preventive Therapy for People Living with HIV(TPT PLHIV). The rates of each of these parameters reported on the Nikshay portal were verified with the registered reports at the district level and were compared.

Result

The research team did not detect the desired sample size of identifying 30 microbiologically confirmed new cases of TB after the completion of study period. Hence, the additional stop rule was applied for the Nashik district. Since 10,616 households were covered, the survey was stopped. The team interviewed 33,601 people from these households. Among 15 survey units, only two survey units concluded their survey after the diagnosis of at least two positive samples as per the methodology. All other survey units continued the survey until the last accepted date of completion.

Estimation of TB prevalence

Direct method:

Total of 546 people were eligible for sputum collection and their sputum was collected and tested. Among these 546 individuals, 474 were symptomatic, 14 were on anti-tubercular drugs at the time of the survey and six were found to be sputum positive during the survey. Thus there were 20 individuals with diagnosed TB and the TB prevalence rate was estimated as 60 per 100,000 population.

Indirect method using Nikshay data:

There were 1968 cases reported on Nikshay portal in Nashik district in 2020. On comparing the survey data and data from Nikshay, all the survey cases identified were reported and hence there was no underreporting. Considering the population of Nashik district as 4,622,165; the prevalence rate was estimated as 43 per 100,000 population for the year 2020.

Indirect method using drug consumption:

Another estimation of TB prevalence was calculated through the consumption of drug formulation containing rifampicin. This was assessed using the schedule H1 register from the drug inspector or local drug manufacturers and suppliers. There were 1778 and 48 patients estimated in public and private sector in Nashik district in 2020. The TB prevalence was estimated to be 40 per 100,000 population in the year 2020.

Decline in rates

The baseline prevalence of TB in 2015 was reported as 112 per 100,000 population. All the three methods of estimates of the TB prevalence concluded that there was a significant reduction in TB prevalence from the baseline year 2015. The reduction was 62%, 46% and 64% as per indirect estimate, direct estimate, and drug consumption estimate, respectively. Thus the reduction based on the estimates in three different techniques was more than 40 percent.

Numbers Needed to Test (NNT)

The number needed to test (NNT) appeared to increase from 2015 to 2020, with a slight dip in NNT in 2017. The change in

NNT in 2020 compared to the baseline was a 17.04% increase in NNT through microscopy and a 41.65% increase through CBNAAT testing (Figure 1). Nashik District could not achieve a minimum increase of 20% in NNT as compared to that in 2015.

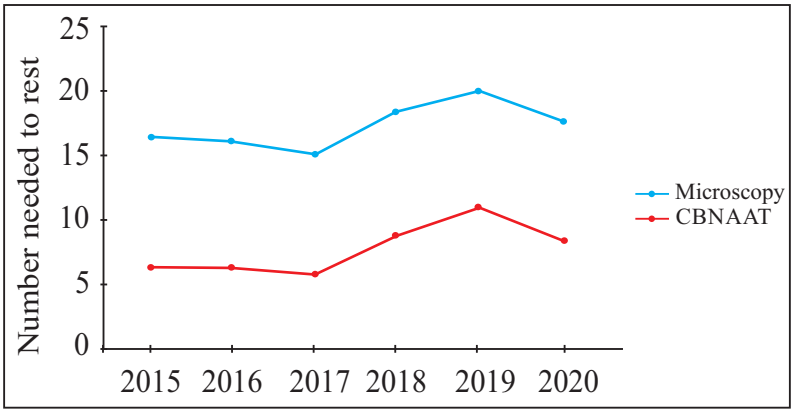

Figure 1: Trend of the number needed to test to find one positive TB case through microscopy and CBNAAT

TB score

The TB score was calculated from the combined rate of nine diversified parameters as shown in table 1. The TB score calculated for the year 2020 was 73 and was less than the required eligibility of 80%.

Table 1: Annual calculated TB score (reported version and verified version) (in percent) from the year 2018 to 2020

Sr. No	Domain	2018		2019		2020	
		Reported	Verified	Reported	Verified	Reported	Verified
1	Notification	12.54	12.54	13.31	13.31	9.66	9.66
2	HIV testing	8.85	7.71	9.64	9.76	9.57	9.99
3	UDST testing	4.84	4.22	10	10	10	10
4	Treatment success	13.55	13.55	13.36	13.36	5.84	5.87
5	DBT NPY payment	5.89	5.89	8.19	8.19	6.39	6.39
6	DRTB treatment	14.32	13.64	12.14	13.04	13.54	13.58
7	Expenditure	4.42	4.42	4.14	4.14	8.93	8.93
8	Children Chemoprophylaxis	0.94	0.94	2.51	2.51	3.76	3.76
9	TPT PLHIV	0	0	5	5	5	5
	Total	65	66.32	78	79	73	73

Abbreviations: HIV: Human Immunodeficiency Virus, UDST: Universal Drug Susceptibility Testing, DBT NPY: Direct Benefit Transfer Scheme Nikshay Poshan Yojana, DR TB: Drug-resistant TB, TPT PLHIV: TB Preventive Therapy for People Living with HIV

Discussion

According to three methods of estimating TB prevalence (indirect estimates based on secondary data, direct estimates based on surveys, and estimates based on drug consumption or utilization), there has been a significant decrease in TB prevalence from the baseline year 2015. The three estimates of the reduction were all greater than 40% (62 percent, 46 percent, and 64 percent, respectively). Additionally, the number needed to test (NNT) seemed to rise from 2015 to 2020, with a modest decline in NNT in 2017.

NNT by microscopy increased by 17.04 percent in 2020 compared to the baseline, while NNT through CBNAAT testing increased by 41.65 percent. But regrettably, Nashik district does not attain the required rise of 20% in NNT compared to 2015. This estimate would closely respond to the year 2009. Our combined estimate is lower than the WHO's national estimate of 390/100 000, based on Gujarat's prevalence adjusted for extra pulmonary and pediatric TB[10].

This was the first instance of subnational level estimation of decline in TB burden along with quality evaluation of the available district-level data. The reduction of TB prevalence

in the district was verified during the ongoing pandemic when human resources and other resources were constrained. Many independent researchers have quantified the impact on TB notification up to the tune of 80% due to diversion of resources or restriction of movement due to lockdown[11]. The reporting of TB was also lower due to the pandemic effect. Hence, the calculated decline may be an overestimation. Though the survey in Nashik district may not show the complete picture of tuberculosis prevalence, it but gives us the scientifically validated data point for future comparison and trend of TB prevalence[12].

Conclusion

Our study results concluded that the reduction of the prevalence of TB in Nashik district is more than 20% compared to 2015. It requires strategic execution to achieve the goal. Therefore, to fulfill TB patients' needs during the ongoing pandemic, prevention, testing, tracing, and care methods for patients with the disease need to be further reformed and re-evaluated in light of the current situation. The Nashik district can improve the current plans and tactics to meet the aim of eradicating TB in India by 2025 with the help of the lessons learned in the fight against COVID-19.

Conflict of Interest: Nil

Source of Support: Nil

ORCiD

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