Infection Prevention in Practice 5 (2023) 100269

Available online at www.sciencedirect.com

Infection Prevention in Practice

journal homepage: www.elsevier.com/locate/ipip

Impact of COVID-19 on the national tuberculosis elimination program in uttarakhand, india: a mixed-methods research study

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ARTICLE INFO

Article history:
Received 26 May 2022
Accepted 13 January 2023
Available online 23 January 2023

Keywords:
Tuberculosis
TB
COVID-19
Notification
Core indicators

SUMMARY

Background: The COVID-19 pandemic has had adverse effects on tuberculosis (TB) management in high-burden countries. We conducted a qualitative study to assess the impact of COVID-19 on Uttarakhand's TB elimination program.

Methods: A mixed-methods study was conducted to assess the impact of COVID-19 on the National Tuberculosis Elimination Program (NTEP) in Uttarakhand, India. We collected secondary data through the NIKSHAY portal from April 1, 2019, to March 31, 2021, interviewed program managers for the qualitative part of the study, and documented changes in some of the program core indicators during the study period.

Results: The study showed a decrease in TB case notification, an increase in the proportion of missing cases, and a fall in the treatment success rate of new cases during the ongoing COVID-19 pandemic by 17%, 54%, and 45%, respectively. Content analysis of in-depth interviews showed disruption in TB-care services because of COVID-19.

Conclusion: TB care services in Uttarakhand have been impacted by measures taken to curb the spread of COVID-19. Both the quantitative and qualitative aspects of the study showed a serious impact on notification rates, diagnostic services, and treatment outcomes for TB patients. In addition, some negative changes have been observed when documenting program indicators (annual case notifications, success rate, treatment success rate) of the National Tuberculosis Elimination Program (NTEP). It is thus predicted that COVID-19 will undermine the Government of India's goal to eradicate TB by 2025 and will negatively affect the TB Program.

Introduction

Tuberculosis (TB) affected a third of the world's population before the COVID-19 pandemic [1]. The World Health Organization (WHO) reported that TB affected approximately 10 million people in 2019. Among the worst-hit eight countries in 2019, India accounts for two-thirds of the new TB cases [2].

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https://doi.org/10.1016/j.infpip.2023.100269

India shares 27% of the global TB burden (10 million cases) and 25% of the worldwide TB mortality [3]. TB remains a significant public health problem in India despite India's flagship National Tuberculosis Elimination Program (NTEP), which is engaged in controlling the disease.

Worldwide, COVID-19 outbreaks have caused more than 6 million deaths [4]. Governments imposed work-from-home policies, travel restrictions, and social isolation to curb the spread. The COVID-19 pandemic has compromised India's public health system and brought attention to its weaknesses. Many well-performing health programs such as the TB program were affected by COVID-19 [1,5]. The COVID-19 outbreak has compromised TB diagnosis, treatment, and prevention, backfiring on the recent improvements in TB detection and reduction. There is a considerable decrease in the number of new cases of TB recorded globally in 2020 compared to 2019. India was the top contributor to the global shortfall in TB notifications, followed by Indonesia, the Philippines, and China. [3].

The disruption in TB prevention and treatment programs may lead to an additional 6.3 million new TB cases, resulting in 1.4 million more deaths by 2025 [6]. TB notifications in India decreased during the lockdown period [7,8] compared to average levels. South Africa experienced a similar reduction.

There is a correlation between COVID-19 and TB control programs, but most evidence is only observed at a national level. Without accurate data, it is difficult to have an accurate estimation. No studies exist to assess the impact of COVID-19 on NTEP, but evidence suggests a negative impact.

NIKSHAY is a web-based application launched by the government of India in June 2012 as part of the National Tuberculosis Elimination Program (NTEP) and which facilitates universal monitoring of access to the data of TB patients by all stakeholders. The NIKSHAY program has been implemented at the national, state, district, and Tuberculosis Unit (TU) levels. Registration of TB patients, pretreatment and follow-up tests, treatment, HIV, and contact tracing are done at the TU level. We obtained secondary data from April 1, 2019, to March 31, 2021, and estimated the effect of COVID-19 on TB case notifications, diagnosis and management. We analysed programmatic indicators of NTEP before and during COVID-19 pandemic and explored the perceptions of program managers to investigate their views about the disease.

Methods

Study design

A mixed-methods study was conducted, in which the quantitative component was a retrospective record review of the routinely collected NIKSHAY data, and the qualitative part was the in-depth interviews of the program managers.

Study settings

With a population of 11.4 million, the state of Uttarakhand is in northwest India, covering a total area of 53,483 square kilometeres. A four-tiered system manages the NTEP, starting at the national level and continuing down to the sub-district level (TB Unit). Each state and district TB office oversees the program's activities. Sub-district and block level activities are directed through the TB Unit. Uttarakhand comprises thirteen districts and 91 TB Units. By the end of 2020, both public and private sectors reported 275 cases of TB per 100,000 persons [9]. For the quantitative part of the study, a simple random sampling method using the lottery technique selected 10 TB Units. Selected TB units were Joshimath, Karnaprayag, Kashipur, New-Tehri, Pratap-Nagar, Ram-Nagar, Rishikesh, Rudrapur, Roorkee, and Rudrap

Study population, sampling, and sampling size

This study included all diagnosed, treated, and notified patients under the NTEP in Uttarakhand from April 1, 2019, to March 31, 2021. District TB officers (DTO), Senior treatment supervisor (STS), Senior TB laboratory supervisor (STLS), and TB health visitors were selected through purposive sampling and interviewed for the qualitative part.

Key time periods

To better understand the impact of COVID-19 on the NTEP in Uttarakhand, this study included two time periods: April 1, 2019—March 31, 2020 (Before the pandemic's onset) and April 1, 2020—March 31, 2021 (During the ongoing COVID-19 pandemic).

Data collection

TB is a notifiable disease in India, and TB patients are registered online at the "NIKSHAY portal," a web-based TB control system. We extracted anonymised records of patients enrolled with the NIKSHAY portal in the selected TB Units from April 1, 2019, to March 31, 2021.

To explore the perceptions of NTEP's program managers, we conducted in-depth interviews with the healthcare workers (HCWs) until the point of saturation. Interviews lasted for 25—30 minutes and were pre-tested before use to ensure participants agreed with the purpose of the interview. Verbatim notes were taken during the interview. Each interview lasted for 25—30 minutes. We read the interview summary back at the end to ensure participant validation.

Statistical analysis

Data were collated in Microsoft Excel ® and imported into version 23 of the statistical program SPSS® (Statistical Package for the Social Sciences). The descriptive data were presented as means and standard deviations for numeric and categorical variables as percentages and proportions.

The qualitative data was translated into English by the Principal Investigator (PI) and then verified by a co-investigator in the area who understood the dialect. Themes were identified for each unit of analysis by manually coding the content.

Ethics approval

The ethics board at AIIMS Rishikesh approved the research **(Letter No.: AIIMS/IEC/21/265 Date: 15/05/2021),** and the facility obtained verbal consent from interview participants.

Table I
Demographic and clinical characteristics of registered patients (N=14898)

Characteristics	Before COVID-19		During COVID-19	
	Number	%	Number	%
Total	8,635	58%	6,263	42%
Age group (in years)				
Child	249	2.9%	114	1.8%
Adolescents	1,364	15.8%	949	15.2%
Young adults	3,899	45.2%	3,009	48%
Middle adults	2,433	28.2%	1,726	27.6%
Older adults	690	8%	465	7.4%
Gender				
Male	4,960	57.4%	3,565	56.9%
Female	3,666	42.5%	2,689	42.9%
Transgender	9	0.1%	9	0.1%
Site of TB				
Pulmonary	2,044	23.7%	1,377	22%
Extrapulmonary	5,264	61%	3,936	62.8%
Unknown	1,327	15.4%	950	15.2%
Case type				
New	6,724	77.9%	4,745	75.7%
Drug-Resistant TB (DR-TB)	210	2.4%	156	2.5%
Re-treatment	704	8.2%	531	8.5%
Presumptive	997	11.5%	831	13.3%
Microbiologically confirmed				
Yes	3,782	43.8%	2,235	35.7%
No	4,853	56.2%	4,028	64.3%
Follow up done				
None	7,838	90.8%	6,133	97.9%
One	760	8.8%	120	1.9%
More than one	37	0.4%	10	0.2%
Contact tracing				
Yes	2,779	32.2%	2,359	37.7%
No	5,856	67.8%	3,904	62.3%
Health facility sector				
Public sector	6,709	77.7%	4,462	71.2%
Private sector	1,926	22.3%	1,801	28.8%
Status of Treatment				
Outcome assigned	7,212	83.5%	2,364	37.7%
Currently on ATT	100	1.2%	2,949	47.1%
Notified and not on ATT	330	3.8%	119	1.9%
Presumptive	993	11.5%	831	13.3%

ATT- Anti-tubercular treatment.

We received administrative approval for the study from the State TB Officer, Uttarakhand.

Results

A total of 14,898 people registered in the NIKSHAY portal from April 1, 2019, to March 31, 2021. Out of the total participants, 8635 (57.9%) registered before COVID-19, while 6263 (42.1%) registered during COVID-19. 1828 (12.3%) of registered participants were indicated as presumptive cases; therefore, 13074 (87.7%) participants were diagnosed with TB during the study period. The participants in this study ranged from 1 to 95 years, with a mean age of 37.2 years (+18.5 SD). TB cases reviewed by us mostly ranged from 20 to 34 years old.

Table II
Case notification, treatment outcome, and clinical characteristics of diagnosed TB patients (N=13074)

Characteristics		Before COVID-19 pandemic		During COVID-19 pandemic	
		N	%	N	%
1.	**Total**	7,642	58.5%	5,432	41.5%
2.	**Case notification***	7,642	58.5%	5,432	41.5%
Treatment outcome					
3.	Treatment complete	4,622	60.5%	1,617	29.8%
4.	Cured	1,625	21.3%	391	7.2%
5.	Deceased	306	4%	119	2.2%
6.	Not evaluated	374	4.9%	15	0.3%
7.	Lost to follow up	295	3.9%	110	2%
8.	Treatment changed	141	1.8%	94	1.7%
9.	Treatment failed	48	0.6%	31	0.5%
10.	Untraceable	52	0.7%	7	0.1%
11.	Duplicate record	29	0.4%	11	0.2%
12.	Patient refused	34	0.4%	11	0.2%
13.	Wrongly diagnosed	11	0.1%	12	0.2%
14.	Missing	105	1.2%	3,014	55.5%
HIV status					
15.	Reactive	70	1%	54	1%
16.	Non-reactive	5,619	73.5%	4,341	80%
17.	Unknown	1,953	25.5%	1,037	19%
Diabetic status					
18.	Diabetic	4	0.1%	25	0.5%
19.	Non-diabetic	68	0.9%	159	2.9%
20.	Unknown	7,570	99%	5,248	96.6%
Microbiologically confirmed					
21.	Yes	3,768	49.3%	2,235	41%
22.	No	3,874	50.7%	3,197	59%
Final interpretation					
23.	Clinically diagnosed TB	3,914	51.2%	3,147	57.9%
24.	Tuberculin skin tests	2,223	29.1%	1,280	23.6%
25.	MTB	741	9.7%	257	4.7%
26.	DRTB	204	2.7%	149	2.8%
27.	RR Indeterminate	18	0.2%	3	0.1%
28.	Missing	542	7.1%	596	11%

Characteristics of registered participants

Out of 8635 registered participants (before COVID-19), 3899 (45.2%) of participants were young adults, and 4960 (57.4%) were males. 2044 (23.7%) had pulmonary TB. Most cases, (6724/77.9%) before COVID-19, were new cases, and 83.5% of them had an outcome assigned, while 11.5% were presumptive cases (Table I). During COVID-19, there were 6263 registered participants; 3009 (48%) were young adults, while 3565 (56.9%) were males. 1377 (22%) had pulmonary TB, and 4462 (71.2%) were in the public sector. Of these registered participants, only 2364 (37.7%) were assigned to an outcome, and 2949 (47.1%) were on treatment (Table I).

Characteristics of diagnosed TB cases

Of the patients diagnosed, 7642 (58.5%) cases were diagnosed before COVID-19, and 5432 (41.5%) cases were diagnosed during COVID-19.

Among the 7642 diagnosed cases during COVID-19, 4622 (60.5%) had completed their treatment, and 1625 (21.3%) cases were cured. The HIV status of 1953 cases (25.5%) was unknown, while the diabetes status of 7570 patients (99%) was unknown. 3874 (50.7%) were not confirmed microbiologically (Table II).

Of the 5432 diagnosed cases during COVID-19, only 1617 (29.8%) had completed their treatment, while 3014 patients were missing (55.5%). HIV status of 1037 (19%) and diabetes status of 5248 (96.6%) were unknown. About 3197 (59%) were not confirmed microbiologically. The treatment outcome of about 3014 (55.5%) was reported missing (Table II).

The rate for annual case notifications decreased when COVID-19 became prevalent. For example, before COVID-19, the rate was 34.3 cases per million persons per year. During COVID-19, the rate was 25.3 per million. During COVID-19, the TB treatment success rate of all the notified cases decreased from 81.7% to 36.9%, and the cure rate of the same decreased from 21.2% to 7.2%. The success rate and cure rate of new cases also decreased during COVID-19 (Table III and IV).

Figure 1 shows the monthly enrollment of participants in the NIKSHAY. Though there is a decrease in the overall registration

Table III
Programmatic indicators

S. No.	Core Indicator	Before COVID-19 pandemic	During COVID-19 pandemic
1	TB Case notification rate (per million per year)	34.3	25.3
2	Notified patients initiated on treatment (%)	84.7%	84.8%
3	New extra-pulmonary TB (%)	59.8%	40.1%
4	New pulmonary bacteriologically confirmed TB (%)	56.5%	46.8%
5	Percentage of pediatric TB patients among total notified cases	6.7%	5.1%
6	Percentage of microbiological confirmed pediatric TB cases amongst the total pediatric	26.7%	20.1%
7	Previously treated, including relapse (%)	9.2%	9.7%
8	Previously treated (including relapses) pulmonary bacteriologically confirmed TB (%).	58.3%	53.6%
9	TB treatment success rate (%) of all the notified TB cases	81.7%	36.9%
10	TB cure rate (%) of all the notified TB cases	21.2%	7.2%
11	Death rate (%) of all the notified TB cases	4%	2.1%
12	Lost to follow up (%) of all the notified TB cases	3.8%	2%
13	Not evaluated (%) of all the notified TB cases	4.8%	0.2%
14	The cure rate (%) of new cases	20.1%	6.7%
15	Success rate (%) of new cases	83.3%	38.4%
16	Percentage of TB & HIV co-infected patients diagnosed among tested	0.9%	0.9%
17	Percentage of TB notified patients with known HIV status	74.4%	80.9%
18	Percentage of TB notified patients offered DM testing	0.8%	3.3%
19	Percentage of MDR-TB diagnosed out of tested	2.4%	3%
20	Percentage of MDR-TB patients started on treatment	100%	100%
21	Treatment success rate (%) among PMTB	34%	13%
22	Percentage of private health facilities actively notifying among the total registered	23%	29%

Table IV
Overview of themes used in the analysis (N=10)

Themes	Sub-themes	Code (n, %)
TB Care Services	TB Diagnosis, Testing, and Case Notification	• Closed OPD (5,50%). • Covid Like Symptoms (5,50%) • Reallocation of Lab Services (6,60%) • Re-Purposing of Staff (6,60%)
	TB Treatment and Management	• Stigma and Fear (7,70%) • Travel and Border Restriction (9,90%) • Stock-Outs (4,40%)
Possible Way Forward	Strengthening Program	• Parallel System (5,50%) • Active case finding (3,30%) • Increase Lab Services (4,40%) • Up Skilled Manpower (2,20%) • Effective Sample Transport System (4,40%)
	Public Awareness	• Media support (2,20%). • Counselling (3,30%)

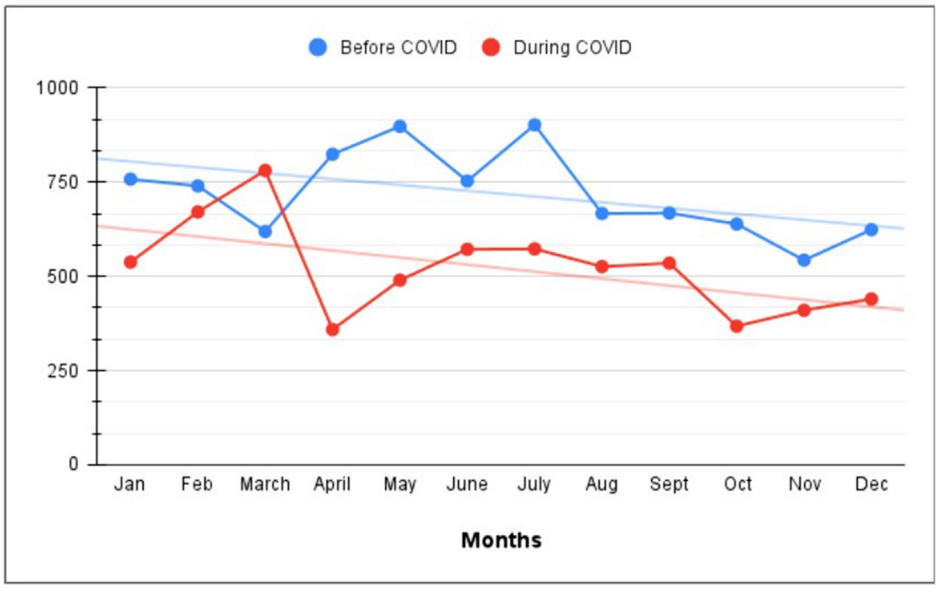

Figure 1. Monthly dynamics of enrollment of participants in the NIKSHAY portal.

of cases during the COVID-19, the maximum drop was observed in April when the lockdown was imposed (Figure 1).

Participant interviews

A total of 10 interviews were conducted with HCWs. Data were organised using two main themes (i) TB care services and (ii) Possible ways forward with four sub-themes that emerged under them.

Extracts from the participant interviews are shown.

(i) TB care services

The subthemes of TB care services are (a) TB diagnosis, testing, and notification and (b) TB treatment and management. Most reported that patients could not reach health facilities because of the closure of general outpatient departments (OPDs) and movement restrictions.

Subthemes.

(a) TB diagnosis, testing, and notification

In most cases, people thought that TB services were affected because of COVID-19. With the general OPDs closed, fewer people attended health facilities. The fear of getting infected contributed to a reduced supply of TB healthcare. COVID-19 and TB both have symptoms similar to cough, fever, and difficulty breathing, so presumptive cases were directed toward COVID care. To prevent the possible COVID pandemic from spreading, HR and lab services were reallocated to fight against it.

"The notification was very less during that time. The first reason was that there was a travel restriction. But there were other reasons too … lab staff were put in covid duties because at that time there were no contractual staff. That is why whatever lab staff were there, whether it was TB staff or the general staff, they were engaged in covid testing. The second symptoms were almost the same, people were nervous about coming to the hospital to get the tests done. Third, most of the hospitals had been made covid care centers or had closed the general OPD for patients So the diagnosis had to come down automatically and, in the beginning, there were a lot of effects."

"Because of the same symptoms, we could not separate the patients. Whatever were the cases of cough and breathlessness, they were considered as suspected covid cases and they were directed for the same. So, we could not deal with the suspected TB cases as most of the patients were directed towards covid detection."

"The biggest effect in the first wave was that for anyone who was coughing or having breathing problems, their RT-PCR, was being taken. The OPD of the big hospital remained closed, due to which the patient also stopped coming and the manpower was also less because the priority was covid."

"Due to lockdown and quarantine, there was difficulty in sample collection and dispatch to molecular diagnostic labs and culture drug susceptibility laboratories."

(b) TB treatment and management

Besides the fear and stigma surrounding TB, COVID-19 has played a double-edged sword, preventing TB patients from gaining access to treatment services and hindering their disease management. The study participants showed that movement restriction and lockdown during COVID-19 have affected several TB prevention strategies, such as regular follow-up and contact tracing of TB patients. Follow-up visits were either canceled or delayed because of the pandemic. During the COVID pandemic, some HCWs revealed that the old stock was exhausted, which caused late diagnosis and affected the program.

"Because the movement of vehicles was stopped, people could not reach here and there from the villages. That is why they could not come to us."

"During covid, there was a lot of fear among people, so the patients stopped coming and did not want to come to the government hospital. We used to call the patients, but they did not want to come and talk to us."

"During covid, there was a lot of interruption because there were no patients, then diagnosis could not be done in the lab and follow up could not be done because the patients could not come. PTB and EPTB could not be diagnosed because TRU-NAAT was not available. There were no cartridges for CB-NAAT, the old stock was exhausted. Mostly Trunat was used for covid patients rather than for TB patients at that time. Samples were not available only, late diagnosis is happening a lot, and a patient has to wait for almost a month to report. Trunat's machine was being used in covid. Due to a delay in diagnosis, there is also a chance of transmission. Backlog is happening, the government should provide us with cartridges. Okay, there is the need for the hour, but there should be an alternative to this."

(ii) Possible ways forward

We asked the study participants about some strategies and ideas to improve the TB care services and improvised the program, and most gave relevant suggestions.

Subthemes.

(a) Strengthening the program

Several participants felt that a parallel system for TB and COVID-19 would be beneficial so that the program wouldn't be affected. Other suggestions include active case finding, an adequate sample transport system, and increasing lab services.

"More lab equipment should be provided."

"TB staff should be kept away from the duty of covid because due to double burden the work will not be done properly. More Centers, Diagnostics, More and More Staff Should Be Appointed."

"First of all, there should be manpower, because we are adjusting manpower from here and there. There should be a parallel system for covid so that no other program would suffer. If we adjust from here and there, then some programs and services will be affected."

"I will again say that active case finding and public awareness should be exclusively done because, at the village level, people still are not willing to test."

"From March 2020 and which was the peak of the second wave during that time, the patients who were on treatment and the patients who were diagnosed, I think they should be backtracked. Make a plan and trace them back and do contact tracing because they are not known yet. So, one can do this so that a little improvement can be done to reduce the specific impact."

"There should be an effective sample collection and transportation system from sub-centers to PHC, PHC to CHC to district / CDST / IRLs."

(b) Public awareness

Any health program relies heavily on public knowledge and media support. Some participants suggested that people should be more aware of TB and that media support will help increase awareness.

"Motivational and media support are very important to fight any outbreak. Misinformation Can Lead to Serious Impact, so proper guidelines should be there for the media also and there should be complete support in making the public fully aware and increasing public knowledge. If the patient is fully aware, then a narrow window will be open for him and he will immediately seek treatment. This will then reduce the Morbidity and Mortality as well."

"At the village level, there should be patient counselling, patient was not willing to give sputum as they still think as this a taboo."

"Public must be as much dedicated as we are. They should be completely aware of TB and its consequences. Mostly illiterate population of India who live in villages as they are not completely aware of signs and symptoms and they take things for granted. Usually, a patient comes to us when he is having breathlessness that is in the complete lungs collapse stage. So public awareness plays a big role in any program."

Discussion

COVID-19 has led to the diversion of resources and a halt to routine healthcare services worldwide, severely impacting TB diagnosis and treatment [10,11]. In our study, we have reported the changes in TB case notifications and other TB services from April 2019 through March 2021. We found out that, after the first lockdown was announced, TB case notifications went down exponentially. Overall, a reduction of 16% (Table II) in case notifications and a drop in the annual case notification rate of selected TUs are seen (Table III). The data illustrates that TB case notifications reported were substantially low even after removing the lockdown. TB services were disrupted in Uttarakhand, and disruptions extended over months rather than weeks. Since the COVID-19 pandemic, fewer TB notifications have occurred worldwide [5,7,12—14].

With the lockdown, many people had less access to treatment for TB. People were scared of contracting COVID-19, and this greatly influenced TB control. The transport restrictions also made it hard for people to reach care centres. A sharp decline in TB notification was observed during October and November because of the beginning of the festival season. Most people stay at home with their families during festival season, and the medical-seeking behaviour of presumptive cases was affected. Many hospitals were closed during the festival period. In this study, TB has been reported higher in males than in females, and one of the probable reasons can be that females have less access to health services because of social stigma and fear [12,13].

The public sector which reported most of the cases reported a drop in registration. Due to a lack of preparedness strategies in the public sector, all other preventative, curative, and continuity of care services were halted. Furthermore, most public hospitals turned away patients who did not have COVID-19. In such cases, the poor have no choice but to forego treatment [17,18]. Our qualitative results showed that because of similar symptoms of TB and COVID-19, most of the symptomatic patients with cough and fever were redirected towards COVID-19 screening, where TB culture testing was not performed, usually leading to further delays in treatment initiation [14]. Field activities are an essential component of the TB program. During field visits, HCWs track contact cases and make the public aware of the signs and symptoms of the disease, but due to the reassignment of staff and lockdown during COVID-19, these services, which are an essential component of TB prevention services were affected. TB laboratories and TB wards were re-assigned to the fight against COVID-19, which also disrupted TB services due to late diagnosis and late initiation of treatment. Delayed diagnosis can lead to the worst outcomes and, in the case of communicable diseases like TB, increases the chances of household transmission [15].

The provision of TB services, and access to these services, was severely disrupted by COVID-19. The adverse effects of COVID-19 comprised 2 main issues. Firstly, it made it difficult for people to use TB services including diagnosis, care, and prevention because not enough providers had the necessary equipment or capacity. Secondly, it also made it difficult for people to access TB services like diagnosis care and prevention either because they were scared of catching COVID-19 from their providers or because of the stigma they faced due to their illness [23].

HIV testing is essential for the clinical management and control of infection in patients with TB [16]. In our study, HIV status was ascertained for most study participants. Most participants with known HIV status were HIV-negative during both periods. Though HIV testing has improved during the pandemic, the HIV status was unknown for many of the study participants during both periods (Table II). HIV co-infection is a significant risk factor for the reactivation of latent TB [17], which indicates that the number of HIV-infected people may have been underreported, making it challenging to provide collaborative TB-HIV interventions and management [18].

Diabetes mellitus is a significant risk factor for developing TB. Many study participants were not screened for diabetes during both periods. Effective diabetes treatment improves TB outcomes [17]. Having well-controlled blood glucose levels may lower mortality risk among people with diabetes and COVID-19 [22]. Thus, there is a need for systematic screening for diabetes status among TB and COVID-19 patients to improve the effective management of both diseases and to prevent complications. The Shenyang Chest Hospital in Liaoning, China, is an example of a health centre that provides integrated care for diabetes, TB, and COVID-19. All patients diagnosed with TB were routinely examined for diabetes and COVID-19, and those with one, two, or three of the illnesses combined are offered and treated with comprehensive therapy [19].

The gold standard for TB diagnosis is to culture *Mycobacterium tuberculosis* in a patient's sputum or other specimens [20]. Over 50% of cases were not microbiologically confirmed during both periods. Similar findings were reported by Huang F *et al*. in their study. The study states that the intercity travel ban, closure of TB laboratory, transfer of laboratory staff for COVID-19 test, and shortage of laboratory reagents for TB were some of the causes of a fall in the microbiologically confirmed patients [21]. Another possible explanation may be the unavailability of courier services because of the travel ban, leading to difficulty in sample collection and dispatch to molecular diagnostic and culture drug susceptibility laboratory.

In the present study, a drop of 45% in the treatment success rate in newly diagnosed TB was seen during COVID-19. The trend was similar for the previously treated cases and drug-resistant cases (PMDT-programmatic management of drug-resistant TB) cases. The previously published reports explain possible reasons for the observed difference in the treatment outcomes between the two periods. A group of ten TB civil society and affected community organisations and networks found out through their survey that 36% of Indian people with TB reported that health facilities were closed, and 50% of people with TB said they feared contracting COVID-19 at a health facility [22].

The Global TB report 2020 states that the measures such as allowing TB patients to take a 1-month or more supply of anti-TB drugs home, closure of outpatient facilities for treatment monitoring or collection of drugs, and expanding the use of remote advice and support have led to poor patient adherence to TB treatment which might have resulted in poor patient outcome [2]. Numerous TB cases had a decreased likelihood of a poor outcome (lost to follow-up, treatment failure, death, or transferred out) during COVID-19 than before. Also, the proportion of missing data on the treatment outcome of many TB cases (new, re-treatment, and PMDT) have increased markedly during COVID-19 (50% rise). These results might be the consequences of containment measures implemented to stop the transmission of COVID or the reassignment of staff from NTEPs to COVID-19-related activities, causing a delay in collecting and reporting data. [2].

We attempted to document some of the TB program indicators in this study. During the ongoing pandemic, there was a decline in the percentage of paediatric TB patients and pulmonary confirmed new TB cases, which might be attributed to under-reporting and parental fear of their children getting exposed to COVID-19 infection.

Our qualitative interviews show that during COVID-19, TB notifications and TB testing were affected because of the diversion of services towards COVID-19. Most interviewees believed that because of similar COVID-like symptoms, people were less likely to report to health facilities. Closure of general OPDs and movement restriction were other indicators of low TB case notifications during the pandemic. Healthcare workers in Uttarakhand during COVID-19 tried their best to ensure the continuous delivery of TB medication to TB patients, which was helpful in achieving favourable treatment outcomes.

Conclusion

In our study conducted in selected TB units, we found COVID-19 had an impact on notification rate, diagnostic services, and treatment outcomes of TB patients. Also, we documented some changes in programmatic indicators of the National Tuberculosis Elimination program (NTEP). During COVID-19, the success rate of TB treatment was also affected.

The fault lines in India's public health system have been revealed by COVID-19. As the pandemic unfolds, we suggest that public health reforms may provide a valuable opportunity to close gaps in TB care programs which are long overdue.

Credit author statement

Kirti Garg: Conceptualization, Methodology, Data collection, Writing- Original draft preparation. **Yogesh Bahurupi:** Supervision, Methodology, Writing- Reviewing and Editing. **Pradeep Aggarwal:** Visualization and validation of findings, Writing- Reviewing and Editing. **Mayank Badola:** Writing-Reviewing and Editing

Funding

This study was funded by the National Tuberculosis Elimination Program, National Health Mission, Uttarakhand. (Operational Research Funds)

Conflict of interest statement

The authors have no conflicts to declare.

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