Study on Effect of COVID-19 on the Incidence of Tuberculosis in Tamil Nadu

Prepared by,

Solidarity and Action Against The HIV Infection in India (SAATHII)

and

State TB Cell, Tamil Nadu

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Study Investigators,

Name	Designation	Department/ Institution	Address for communication
Principal Investigator (PI)			
Dr. A. Sathish Kumar	SAATHII, Country Director	SAATHII	Solidarity and Action Against the HIV Infection in India (SAATHII) New No. 30 (Old No. S-23), 35th Cross Street, Besant Nagar, Chennai 600090, Tamil Nadu, India Landline (+91 44) 2440 3947/3663 +91 938057055 drsathish3@saathii.org
Co-Principal Investigator (Co-PI)			
Dr. Karun Sandeep Veesa	State Technical Specialist	SAATHII	Solidarity and Action Against The HIV Infection in India (SAATHII) H.No.-1-4-880/2/36/1, New Bakaram, Gandhinagar Hyderabad-500080 +91 9894471992 karunsandeep@saathii.org
Dr. Asha Frederick	Additional Director of Medical & Rural Health Services(TM) & State TB Officer	State TB Cell	Additional Director of Medical & Rural Health Services(TM) & State TB Officer, National TB Elimination Programme, State TB Cell, Tamil Nadu, +91 9498409042 stotn@rntcp.org
Dr. K.V Suma	WHO Consultant	State TB Cell	National TB Elimination Programme, State TB Cell, Tamil Nadu,
Co-Investigators of the study			
Dr. Aarthi	State TB Officer	State TB Cell	National TB Elimination Programme, State TB Cell, Tamil Nadu
Dr.Delphina Peter Pathinathan	WHO Consultant	State TB Cell	National TB Elimination Programme, State TB Cell, Tamil Nadu
Dr.Raghavan Parthasarathy	WHO Consultant	State TB Cell	National TB Elimination Programme, State TB Cell, Tamil Nadu
Dr.Bhavani Niveda	WHO Consultant	State TB Cell	National TB Elimination Programme, State TB Cell, Tamil Nadu
Dr. Jerome J Thampi	WHO Consultant	State TB Cell	National TB Elimination Programme, State TB Cell, Tamil Nadu
Dr. Deiveegan Chidambaram	WHO Consultant	State TB Cell	National TB Elimination Programme, State TB Cell, Tamil Nadu

List of Acronyms

ACF	Active Case Finding
AIIMS	All India Institute of Medical Sciences
ANC	Antenatal care
ATT	Anti-tuberculosis treatment
BMO	Block Medical Officer
CBNAAT	Cartridge Based Nucleic Acid Amplification Test
CCC	COVID care centre
CHC	Community Health Centre
CT Scan	Computed Tomography Scan
DBT	Direct Benefit Transfer
DDHS	District director of health services
DPC	District Program Coordinator
DR-TB	Drug resistant TB
DS-TB	Drug sensitive TB
DTO	District Tuberculosis Officer
EPTB	Extra pulmonary TB
FGD	Focus Group Discussion
GH	General Hospital
GNM	General nursing and midwifery
HCP	Healthcare provider
HIV	Human immunodeficiency virus
HOD	Head of the Department
IAP	Indian Academy of Pediatrics
ICCC	Integrated command and control centres
ILI	Influenza like illness
IMA	Indian Medical Association
KII	Key Informant Interview
LD	Lockdown
LT	Lab Technician
MO-DTC	Medical Officer District Tuberculosis Centre
MO-TC	Medical Officer Tuberculosis Centre
MTM	Makkalai Thedi Maruthuvam
NAAT	Nucleic Acid Amplification Test
NCD	Non communicable diseases
NGO	Non-governmental organization
NTEP	National TB Elimination Program
PCR	Polymerase chain reaction
PHC	Primary Health Centre
PHI	Peripheral Health Institute
PLHIV	People living with HIV

PMA	Professional Medical Association
PPM	Public and private mix
PR TB	Presumptive TB
PTB	Pulmonary TB
PTLFU	Pre-treatment loss to follow up
RAT	Rapid Antigen Test
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SARI	Severe acute respiratory illness
SSI	Semi-structured interview
STLS	Senior Tuberculosis Laboratory Supervisor
STS	Senior Treatment Supervisor
TB	Tuberculosis
TB-HV	Tuberculosis Health Visitor
TN	Tamil Nadu
UDST	Universal Drug Susceptibility Testing
UHN	Urban Health Nurse
ULD	Unlock down
UPHC	Urban Primary Health Centre
VHN	Village Health Nurse
W1, W2	Wave1 and Wave 2
WHV	Women Health Volunteer

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I. Introduction

A. Study background and rationale

Globally, TB was the second leading cause of mortality among infectious diseases in 2020, after COVID-19[1]. India contributes to one-fourth of the global TB burden[2]. The COVID-19 pandemic, caused by SARS-CoV-2, has affected the global health situation and economy due to lockdowns and other restrictive measures implemented by governments. India has been ranked second globally with respect to COVID burden with 3.45 crores COVID cases and 4.68 lakhs COVID deaths[3].

The Indian government took necessary public health measures including the complete lockdown and phased manner of lifting restrictions. Despite these measures, the country faced two peak waves of COVID-19. The first wave commenced with increased detection of cases in January-March 2020. After the September 2020 peak, cases declined by the end of October 2020. Subsequently, a period of low COVID-19 incidence occurred between November 2020 and mid-February 2021. The second wave commenced in India in April-May 2021, peaked in May 2021 and then declined till December 2021[4].

These COVID peaks strained the health systems due to the diversion of resources including both frontline health workers and facility-based personnel and infrastructure towards COVID containment and management[5], and subsequently for COVID vaccination in the second half of 2021. These health system challenges, coupled with fear of COVID among the general population, affected both the access and uptake of health services throughout the country.

A survey on problems faced by TB patients during the COVID pandemic, conducted by AIIMS-Patna, a tertiary referral centre, revealed almost one-fifth of patients (17.33%) defaulted tuberculosis treatment due to lockdown, as they could not get the medicine and one-fifth (20.96%) were forced to purchase the medicine from private pharmacies. Most of the patients agreed that staying indoors is the most effective strategy to avoid infection by corona infection[6]. In addition, TB patients could not access health services due to COVID situation and were confined within their homes, increasing the likelihood of active transmission in the household contacts. Also, it was anticipated that delay in accessing health services could lead to increasing TB related morbidity and mortality, due to non-diagnosis, delays in diagnosis, failure to initiate treatment, and patients discontinuing anti-TB medication, due to lockdown and other restriction measures[7]

[1] Tuberculosis factsheets, 27 Oct 2022. https://www.who.int/news-room/fact-sheets/detail/tuberculosis
[2] WHO. (2021). Tuberculosis factsheets. Geneva: WHO. https://www.who.int/news-room/fact-sheets/detail/tuberculosis
[3] WHO, COVID-19 Dashboard. https://covid19.who.int/region/searo/country/in
[4] https://www.worldometers.info/coronavirus/country/india/
[5] Chasing the virus: A public health response to the COVID-19 pandemic. https://nhsrcindia.org/sites/default/files/2022-07/Chasing_the_Virus_A_Public_Health_Response_to_the_COVID-19_Pandemic_02032021_1.pdf
[6] Indianjournaloftuberculosis67(2020)S173eS174: https://www.sciencedirect.com/science/article/pii/S0019570720300846?via%3Dihub
[7] Tuberculosis and COVID-19 in India- Double trouble! https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7366998/

A modelling study[8] by Stop TB Partnership on the impact of COVID-19 on TB cases, projected an excess of 232,655 TB cases that would occur in India from 2020-2025 for every month of lockdown, and 144,795 for every month of restoration time. Also, an excess of 71,290 excess deaths for every month of lockdown and for every month of restoration, an excess of 40,685 deaths is expected. Hence the study recommended a rapid restoration process after lockdown to prevent the future impact on TB.

In relation to this, the state NTEP program followed best practices during COVID-19 pandemic[9], - a circular was issued on 26 March 2020 on TB drugs distribution at doorstep of TB patients, multi month dispensation of TB drugs and detailed guidance to program implementers on strategies to enhance the TB activities, regular reviews at the state levels to discuss the achievements, challenges and good practices were conducted, drug distribution efforts were coupled with follow-up sputum collection and TB knowledge awareness activities. In addition, the guidance from the Central TB Division on 4 September 2020, - 'Rapid response plan to mitigate impact of COVID-19 pandemic on TB epidemic and NTEP program activities in India'[10] where state and districts advanced innovative solutions to increase case detections.

Despite these measures, there was a 24% decline in country's TB notification from 24.04 lakhs in 2019 to 18.05 lakhs in 2020 and a case fatality ratio increased from 17% in 2019 to 20% in 2020[11]. Also, the recently completed India national TB prevalence survey 2019-2021 reports, prevalence of all forms of TB among all age groups in India (per 100 000 population) stands at 312 (286 – 337) and state Tamil Nadu is higher than the country, stands at 314 (219-410)[12]

In line with the above national scenario on the challenges faced by the health system and people with health needs, Tamil Nadu, also faced similar challenges, even though its health system is stronger relative to many other states,

The current study examines COVID-19 impact on TB notification, access and uptake of services in reference to diagnostics, treatment initiation, drug availability/supply, adherence, treatment outcomes, and mortality, thus it aids in application for epidemiological, medico-social, clinical, and socio- economic interventions that are expected to reduce morbidity and mortality from the interaction of COVID-19 and TB in both the short- and long- term**.**

[8] Stop TB Partnership: The potential impact of the covid-19 response on Tuberculosis in high-burden countries: a modelling analysis

[9] Tamil Nadu Best practices during COVID-19 pandemic. Accessed from Central TB Division website homepage

[10] Rapid response plan to mitigate impact of COVID-19 pandemic on TB epidemic and NTEP program activities in India. https://tbcindia.gov.in/WriteReadData/l892s/60159559755DODDG_NTEP%20Rapid%20Response_Full.pdf

[11] WHO. (2021). Global tuberculosis report 2021

[12] National TB prevalence survey (2019 – 2021), https://tbcindia.gov.in/showfile.php?lid=3659

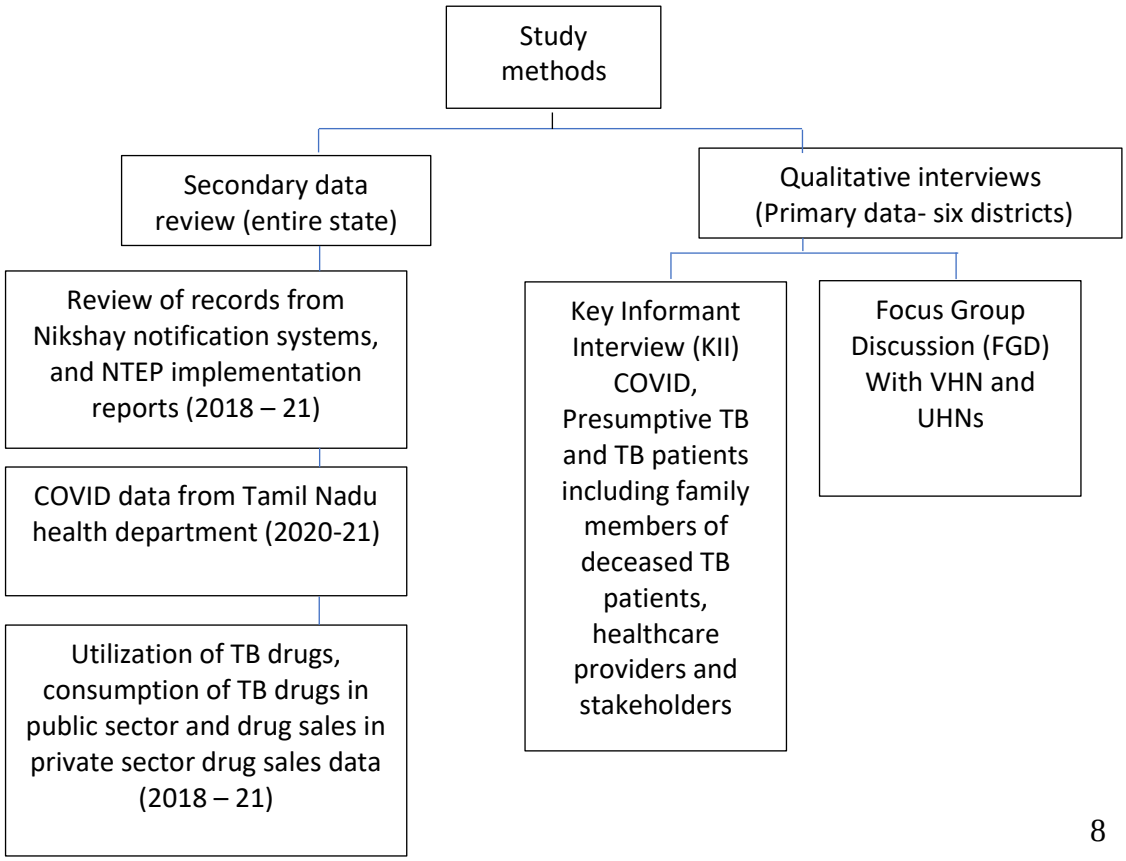
B. Study goal and objectives

Goal: Assess the impact of COVID-19 on incidence of TB in Tamil Nadu	**Objective 1:** Assess the effect of COVID interventions and restriction measures on TB notifications and incidence in Tamil Nadu during 2020 and 2021, in comparison with Years 2018 and 19, to inform preparedness for future COVID and other similar pandemic situation
	Objective 2: Examine the effect of COVID and associated restrictive measures on access and uptake of TB services in Tamil Nadu with reference to diagnostics, treatment initiation, drug availability/supply, adherence, treatment outcomes, and mortality [for Drug Susceptible and Drug Resistant TB patients)
	Objective 3: Understand the perceptions of health care providers and people accessing TB services on the effects of COVID on the TB screening to treatment completion cascade and the measures taken for mitigation

II. Study Methodology

The study employed a mixed methods approach, including review of secondary data on COVID and TB, and qualitative analysis of inputs from health care providers, patients and diverse stakeholders on their experiences on COVID and TB in the program, including barriers, facilitators and suggestions for further improvement. Figure 1 shows the study methodology.

Figure 1: Flow of study methodology



A. Primary data collection

Primary data were collected through key-informant interviews and focus group discussions from six districts of Tamil Nadu. The rationale for district selection is presented below,

COVID-affected population per district is in the range of 1.5% – 12.2% across the state. Therefore, districts were categorized based on the COVID burden as high, moderate and low COVID burden geographies (see Annexure 1) as:

- > 4% people affected with COVID as high burden districts
- 2.6 - 4% people affected with COVID as moderate burden districts
- ≤ 2.5 % people affected with COVID as less burden districts

The state average decline of TB notification during 2019-20 years was 56 per lakh population and the rise of TB notification during 2020-21 years was 17 per lakh population. In addition, study districts were further categorized based on decline in TB notification from 2019 to 2020, and increase in TB notification from the COVID affected population in each district from 2020 to 2021, presented in a 2*2 table (Table 1)

Two districts were purposively selected from each COVID burden category, based on directional changes in TB notifications (decline from 2019 to 2020 and increase from 2020 to 2021).

Table 1: Rationale of study district selection for conducting qualitative interviews

	High decline (≥56)				**Low decline (<56)**			
	District	**Decline**	**Increase**	**COVID population**	**District**	**Decline**	**Increase**	**COVID population**
High increase (≥ 17)	Chennai	140	53	12%	Dindigul	52	27	2%
	Madurai	95	30	2%	Perambalur	48	26	2%
	Theni	78	25	4%	Villupuram	45	20	4%
	Erode	95	19	5%	Cuddalore	44	17	2%
	Kancheepuram	60	31	7%	Pudukkottai	49	23	2%
	Tirunelveli	60	21	3%				
	Salem	59	17	3%				
Low increase (<17)	Tiruchirappalli	91	13	3%	Coimbatore	42	11	7%
	Virudhunagar	65	10	2%	Dharmapuri	33	7	2%
	Thanjavur	64	15	3%	Namakkal	40	9	3%
	Tuticorin	58	10	3%	Tiruvarur	35	10	3%
	Ramanathapuram	63	6	2%	Krishnagiri	24	1	2%
	Sivagangai	58	5	7%	Vellore	30	13	3%
					Nagapattinam	36	6	3%
					Karur	47	16	2%
					Tiruppur	29	12	4%
					Tiruvannamalai	33	5	2%
					Kanyakumari	36	10	3%
					Tiruvallur	21	10	3%
					The Nilgiris	16	0	5%

Six districts were purposively selected from all 4 quadrants based on the COVID burden in districts

1. High COVID burden (>4%)
   a) Kancheepuram
   b) Coimbatore
2. Moderate COVID burden (2.6 - 4%)
   a) Tiruchirappalli
   b) Villupuram
3. Low COVID burden (≤ 2.5%)
   a) Madurai
   b) Dharmapuri

B. Secondary data collection: Data sources

Table 2: Source documents for TB: Secondary data for the entire state from NTEP program

S.no	Name of the document	Source	Years	Provided by
1	TB notification register	Nikshay	2018 - 2021	State TB cell
2	Co-morbidity register	Nikshay	2018 - 2021	State TB cell
3	Contact tracing register	Nikshay	2018 - 2021	State TB cell
4	Annexure M (Presumptive TB testing by Sputum microscopy)	State TB cell	2018 - 2021	State TB cell
5	Active Case Finding (ACF) register	State TB cell	2018 - 2021	State TB cell
6	CBNAAT indicator report	State TB cell	2018 - 2021	State TB cell
7	Truenat indicator report	State TB cell	2020 - 2021	State TB cell
8	Best practices followed during pandemic	State TB cell	2020	State TB cell
9	State public and private sector drug sales data	State TB cell	2018 - 2021	State TB cell

TB care services are delivered in Tamil Nadu through a 3-tier health directorate system – Directorate of Public Health and Preventive Medicine, Directorate of Medical and Rural Health Services and Directorate of Medical Education providing primary, secondary and tertiary care respectively. There are 35 NTEP districts, each of which is subdivided into TB units (which typically correspond to health blocks). Five of these 35 districts are located within Chennai, hence the study considered Chennai as a single unit and 31 NTEP districts were taken under study analysis.

Further, each TB unit has public sector peripheral health institutions (PHIs) and private sector hospitals/clinics/labs/pharmacies under its purview. In the public sector, there are medical colleges, district headquarters hospitals, sub-district hospitals, block primary health centers, primary health centers and health sub-centers – these public sector facilities are termed as peripheral health institutions (PHIs). Out of these, some PHIs are equipped as designated microscopy centers. In addition, there are a total of 140 Truenat machines and 75 CBNAAT machines in secondary and tertiary PHIs. The vast infrastructure of the NTEP is manned and

supported at the district level by a team of DTO, DPC, DRTB & TB-HIV coordinator and at the field level by STS, STLS, TB-HV and LTs[13].

Table 3: Source documents for COVID: Secondary data for the entire state from COVID program

S.no	Name of the document	Source	Years	Provided by
1	TN positive COVID cases	COVID database	Mar 2020 to Dec 2021	State health department
2	COVID active cases	COVID database	Mar 2020 to Dec 2021	State health department
3	TN COVID discharge	COVID database	Mar 2020 to Dec 2021	State health department
4	COVID positives, men and women	COVID database	Mar 2020 to Dec 2021	State health department
5	Total samples tested	COVID database	Mar 2020 to Dec 2021	State health department
6	COVID deaths	COVID database	Mar 2020 to Dec 2021	State health department
7	COVID bed capacity	COVID database	Mar 2020 to Dec 2021	State health department

The state health department has been collecting data on COVID-19 testing, cases, hospitalizations, deaths and vaccinations to monitor the spread of infection and make informed decisions about public health policies. In this report, we abstracted the data received from the state health department on COVID-19 testing, positive cases, institutions, hospitalizations and deaths. The data cover the period from March 2020 to December 2021 and provide a snapshot of the COVID-19 situation in Tamil Nadu.

C. Study population

The study participants included health care providers (HCPs), program stakeholders, patients from six study districts, and nodal officials.

i. The different cadres of HCPs and program managers selected for interviews were:
   - Health care providers from the public sector Medical Officers, Staff Nurse,
   - NTEP staff –PPM Coordinator, MO-TB, STS, STLS and TB HVs,
   - Frontline workers – VHN and UHNs
   - Private Doctors, and Pharmacists
   - Program leads-
     - District program managers – DTO , DDHS, JDHS, CMOs, BMOs and Hospital Superintendent
     - State Medical Officer for TB

ii. The patient groups included:
   - COVID positive patients
   - Presumptive TB and TB patients
   - Family member of deceased TB patient

[13] Tuberculosis case finding in the public sector in Tamil Nadu – Trends and experiences from 2015 to 2022

Eligibility criteria for primary data collection

i. Inclusion criteria –
   - Patients reported in COVID and TB program
   - Family member of deceased patients
   - Parents of children selected from the TB notification line list
   - Those who provided consent

ii. Exclusion criteria –
   - Refused to provide consent for study participation

D. Study definitions

- Presumptive TB - A person having presumptive TB symptoms, investigated for the presumptive TB symptoms, and reported to the TB program under NTEP Lab register. Study interviewed person with Presumptive TB as those who were identified as Presumptive TB and found to be TB negative after evaluation.
- Diagnosed TB - A person diagnosed with TB, reported to the TB program through a Nikshay notification portal
- Family member of a deceased TB patient – Family member of a patient who initiated on treatment and died during the treatment period
- COVID positive - A person with COVID symptoms, investigated either with Rapid antigen or RT-PCR test or Truenat and found positive for COVID
- Current facility – Current facility in the Nikshay TB notification register is the facility where patients registered and started on TB treatment and make periodic visits for the ATT treatment following TB diagnosis
- COVID testing - Rapid Antigen Test (RAT) or RT-PCR or Truenat are the methods used for COVID testing. All symptomatic COVID cases and the contacts underwent testing. The data of COVID testing and COVID positives are managed through a centralised database maintained by the state health department.
- Presumptive TB testing - Sputum microscopy and NAAT (CBNAAT or Truenat) procedures are largely utilised for a presumptive TB testing under National TB Elimination Program (NTEP). Presumptive TB testing by sputum microscopy which gets reported under Annexure M in the NTEP program and CBNAAT, Truenat indicator reports was used for this analysis.
    - Annexure-M of NTEP programme report regarding the performance of sputum microscopy prepared at the level of peripheral health institutions and consolidated at levels of TB unit, district, and state for a month, quarter, and year. This report contains the number of new adult out-patients, presumptive TB tested, presumptive TB who test positive, etc.
    - CBNAAT indicator report: monthly report regarding the performance of CBNAAT machines submitted by each CBNAAT site for each machine. This report is also consolidated at the level of district and state for a month, quarter, and year. It contains details on total tests conducted on CBNAAT, presumptive TB tested on CBNAAT, presumptive TB who test positive, etc.
    - Truenat indicator report: monthly report regarding the performance of Truenat machines submitted by each Truenat site for each machine. This report is also consolidated at the level of district and state for a month, quarter, and year. It contains details on total tests conducted on Truenat, presumptive TB tested on Truenat, presumptive TB who test positive, etc.

- Nikshay: Nikshay is the digital case-based reporting system of the National Tuberculosis Elimination Programme. Notification registers containing detailed line lists of all TB patients diagnosed within the state and reported to the government NTEP system were downloaded for the period from 2018 to 2021.

E. Study sampling and sample size

Purposive sampling, a non-probability sampling technique, was used in the study to select participants based on the type of participants,

A. **Patients:** From each district, nine semi-structured Interviews (SSIs) were conducted with individuals living with TB, those with presumptive TB, and those with COVID, totalling 54 SSIs across all six districts. Wherever possible, a family member of a deceased TB patient was also included
B. **Health care providers and program stakeholders**: Consenting HCPs belonging to different cadres across the six selected districts were approached to participate in SSIs. From each district, primary, secondary and tertiary public health facilities and private hospitals, clinics, including pharmacies were proposed to be included. A total of 102 SSIs with health care providers, 18 SSIs with programme stakeholders, 54 SSIs with patients, 12 FGDs and 6 NGOs were proposed as the sample size, as detailed below in Table 4.

Table 4: Proposed sample of patients, health care providers and program managers

Per district	Primary (PHC) – Rural and Urban	Secondary (Taluk, Sub-district hospitals)	District Hospitals/Medical College	Private facilities (including chemists)	Patients	Total
District Health Department (DDHS/BMO/DTO) Stakeholders						3
NTEP staff (STS, STLS, TB HV, Lab technicians, Radiologist, Pharmacist)		3	2			5
Medical Officer (Clinician)	1	1	2			4
Staff nurse/GNM	1	1	2			4
Private Physician/consultant				2		2
Private Pharmacist				2		2
TB patients					3	3
Presumptive TB patients					3	3
COVID cases					3	3

Per district	Primary (PHC) – Rural and Urban	Secondary (Taluk, Sub-district hospitals)	District Hospitals/Medical College	Private facilities (including chemists)	Patients	Total
Frontline workers (VHN/UHN) - FGD	1	1				2
TB-HIV/ NGO						1
Total interviews (including FGD) per district						**32**
For six districts, 6* 20 = 120 health care provider and stakeholder interviews; with health care providers (102), stake holders (18) For six districts, 6*9 = 54 patient interviews (3 COVID + 3 TB + 3 Presumptive TB per district), For six districts, 6*2 = 12 FGD (2 FGD per district - UHN/VHN); For six districts, 6*1 = 6 NGO (1 NGO per district)						

Overall, the study conducted 203 KII and 11 FGDs from six study districts. Details of study participants interviewed from each district are in Annexure 2.

F. Selection procedures

For the selection of participants, the study team conducted a two-day scoping visit to the districts prior to primary data collection, to understand the distribution of facilities and client coverage during the pandemic, number of healthcare facilities and the cadres of health professionals available in each facility.

The selection of the specific study sites within the district (urban and rural blocks) as well as of the participants was made in consensus with the district level senior health officials. With their inputs, the SAATHII team selected CHCs, PHCs and the UPHCs, in addition to the Government Hospitals (GH) and Medical Colleges from urban and rural blocks in each selected study district.

Interviews were conducted with the respective stakeholders (DDHS, JDHS, MS District hospital, DTO) at each district based on their willingness to take part in the study. The selection of health care providers at each facility was based on the inputs from the Head of the Department (HOD) and the in-charge staff of the respective facilities.

The selection of patients was based on the line list of presumptive TB (NTEP Lab register) and TB (Nikshay portal) patients who were diagnosed during waves (W1 and W2) of the COVID-19 pandemic. Patients were contacted over the phone and those who consented were interviewed at the facility. For study participants who were unable to visit the facility, phone call interviews were conducted after obtaining recorded verbal consent. In each district, two Focus Group Discussions (FGDs), one each with VHNs and UHNs at the block level, were also carried out. Efforts to reflect Urban/Rural differences, experiences during Wave 1/Wave 2, and different kinds of TB patients (DR-TB/ DSTB/ EPTB/ HIV TB/ ANC TB) were also made.

G. Study guides

Separate guides were developed for HCPs and for patients. The guides meant for the HCPs (FGDs for community health workers and interviews with facility-based health care providers) sought to elicit information on the following:

- Availability of TB services, TB diagnostics and treatment, referrals, and linkages
- Uptake of TB services
- Issues concerning drug supply to TB patients and monitoring adherence, issues on contact tracing and follow up
- Perceptions about the COVID situation and its effect on healthcare seeking behaviour
- Good practices of providers
- Challenges in access and uptake
- Recommendations

The guides for the patient interviews explored:

- Experiences in seeking care during the pandemic
- Challenges in getting tested for COVID/TB, getting diagnosed obtaining treatment
- Any delays in initiation of treatment, obtaining medicines
- Perceptions on quality of treatment
- Nature of support received from both public and private health sector
- Suggestions to improve care services

H. Data management and analysis

All the secondary data from the COVID and TB program were shared with study team in Microsoft Excel™ format source files, cleaned and validated by the study team. After the dataset was cleaned and validated, it was imported into a master database for further analysis using Stata 14.0 (Stata Corp. 2015. Stata Statistical Software: Release 14. College Station, TX: Stata Corp LP.)

All the audio recorded SSIs and FGDs were transcribed verbatim and then translated into English (wherever necessary). The English transcripts were loaded into NVivo (NVivo qualitative data analysis software; QSR International Pty Ltd. Version 12, 2018). Data were analysed using thematic analysis as described by Clark and Braun (2013), in six stages. The first was the data familiarization through repeated readings of the interview transcripts. Next came the process of coding. Three transcripts were initially coded independently by two coders. After independently coding 3 interviews, we expanded the existing code book and added codes and categories inductively derived from the interviews. Any differences in coding were discussed and resolved. The remaining transcripts were coded using this code book. New points emerging from these interviews relevant to our study, were given a new code and is incorporated within the book. We then began to cluster the codes according to similarity and regularity, thereby facilitating the development of categories. In the third stage we began to search for themes which meant looking for "coherent and meaningful patterns in the data" relevant to our research questions. We collated all the coded data relevant to each theme. In the fourth stage we began to review the themes and to reflect on whether these themes actually related well to our data, were convincing and credible, whether two or more themes needed to be collapsed into one theme or were best as a stand-alone theme. In the fifth stage we started to label and define each theme, describing in detail what it signified in the context of our study and in the 6th stage we brought forth a coherent explanation of our study findings. Sifting through the data, we then sorted and selected quotes and placed them under appropriate themes.

III. Study Results

The impact of COVID-19 on TB reporting, notifications, access and uptake of TB care services and treatment completion in 2018-2021 is presented in this report. It includes findings from the secondary data analysis of the state COVID and TB program data and key findings from qualitative study in the six study districts (among 35 NTEP districts), Kancheepuram, Coimbatore, Tiruchirappalli, Viluppuram, Madurai and Dharmapuri districts. The qualitative analysis is based on 203 Key informant interviews (KII) and 11 Focus group discussions (FGDs).

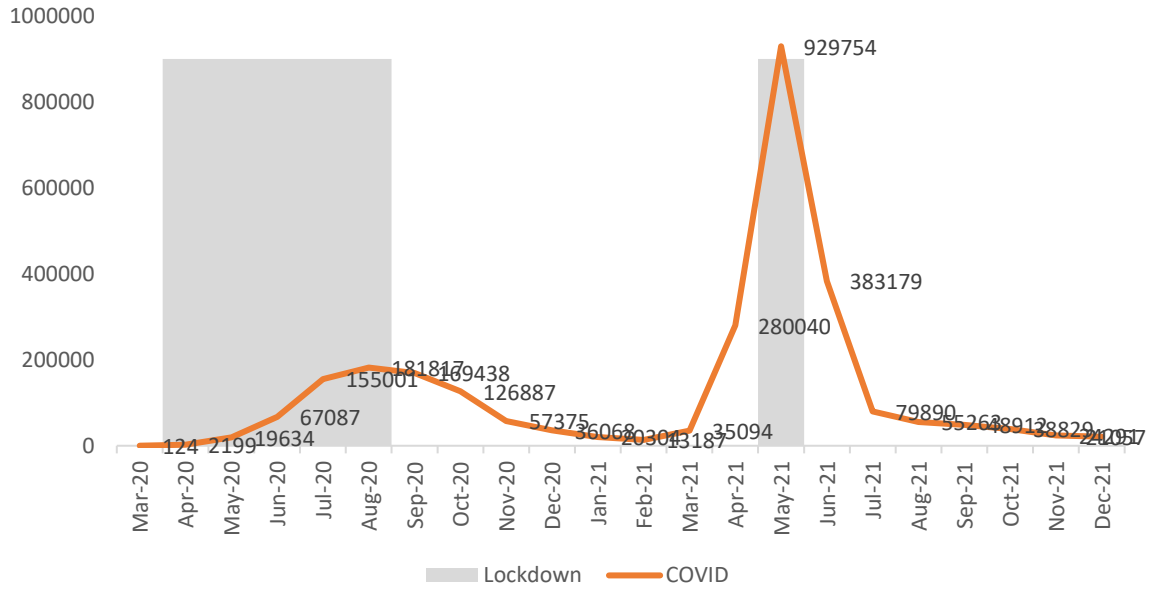
A. COVID-19 Scenario in Tamil Nadu

The study presents the key findings of the data received from the state health department on COVID-19 testing, positive cases, institutions, hospitalizations and deaths. The data cover the period from March 2020 to December 2021 and provide a snapshot of the COVID-19 situation in Tamil Nadu.

COVID-19 cases in Tamil Nādu during years 2020 and 2021

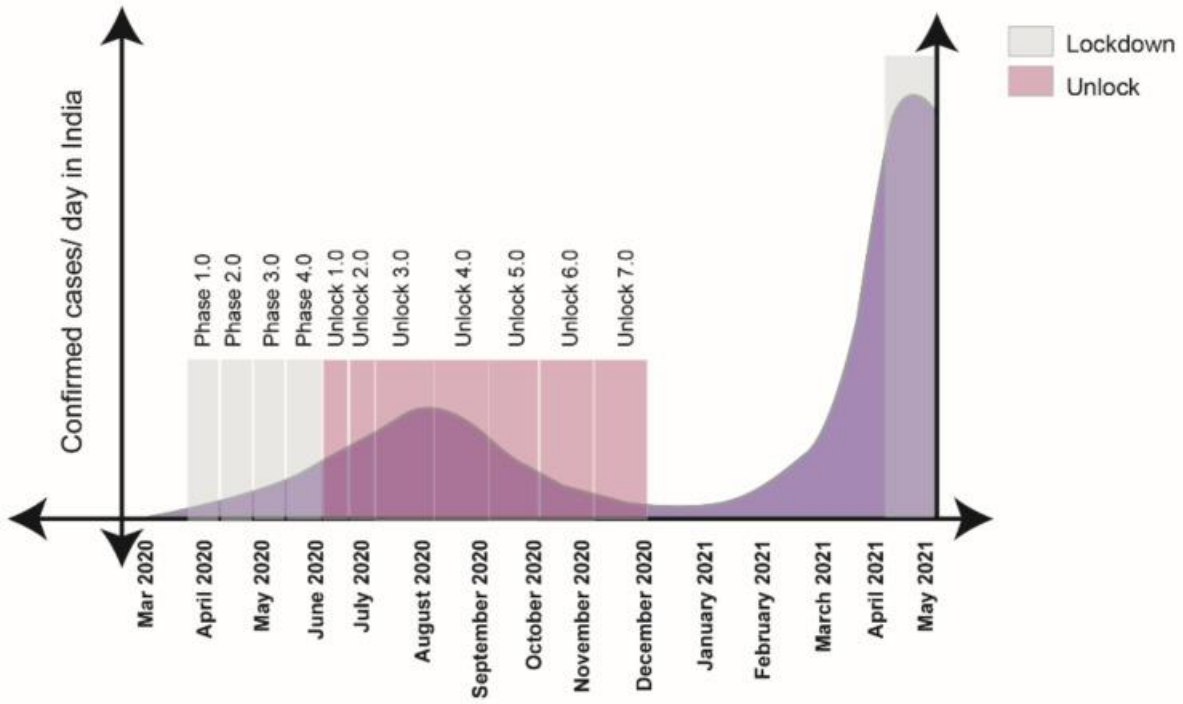
Overall, 27,45,430 COVID-19 cases were reported March 2020 to December 2021 across the state. The numbers do not include cases reported from the airports and railway quarantine. The maximum number of cases per month, 9,29,754 was reported in May 2021. The COVID-19 pandemic in the state exhibited two sequential waves (W1 and W2) with a gap of four months (Nov 2020 - Feb 2021) between them. Lockdowns during waves and un-lockdown/ recovery phases following W1 and W2. The below figure presents the month wise COVID-19 cases and lock-down periods in Tamil Nadu.

Figure 2: COVID-19 in Tamil Nadu from March 2020 to December 2021



For this study analysis, we quote below from the study by Sarkar et.al, (2021)[14]

Figure 2a. Phases of lockdown, unlock and COVID in India from March 2020 to May 2021



"The diagram shows that in the first wave, the nationwide lockdown in India started at the end of March and lasted up to June 2020, followed by unlocking from the end of June 2020 to December 2020. In second wave, the state-wise lockdown has been implemented from April 2021.

"A detailed description of the lockdown and the unlock phases in India is presented [above]. With the onset of the first wave in India, the Government imposed a lockdown all over the country in four phases, i.e., Phase 1: 25 March–14 April 2020, Phase 2: 15 April–3 May 2020, Phase 3: 4 May–17 May 2020, Phase 4: 18 May–31 May 2020. The lockdown was gradually withdrawn in several steps to balance the need to provide safety from the virus and restore the economic growth of the country. Lockdown withdrawal phases were as follows: Unlock 1.0: 30 May–8 June 2020, Unlock 2.0: 1 July–31 July 2020, Unlock 3.0: August 2020, Unlock4.0: September 2020, Unlock 5.0: October 2020, Unlock 6.0: November 2020, Unlock 7.0: December2020. Over time, India started experiencing a low number of CODID-19-positive cases and during February 2021, the number of COVID-19 confirmed cases/day was very low, which indicated that the first wave of COVID-19 was close to an end. However, the unexpected sharp rise of confirmed cases towards the end of March 2021 indicated the initiation of the second wave in India. State-wide lockdown was found beneficial for managing COVID-19 confirmed cases in the second wave of infection as after few weeks of the implementation of the lockdown, the number of confirmed cases/day dropped evidently."

[14] Sarkar A, Chakrabarti AK, Dutta S. COVID-19 Infection in India: A Comparative Analysis of the Second Wave with the First Wave. Pathogens. 2021 Sep 21;10(9):1222. doi: 10.3390/pathogens10091222. PMID: 34578254; PMCID: PMC8469101.

COVID waves in Tamil Nadu

a. First wave (W1):

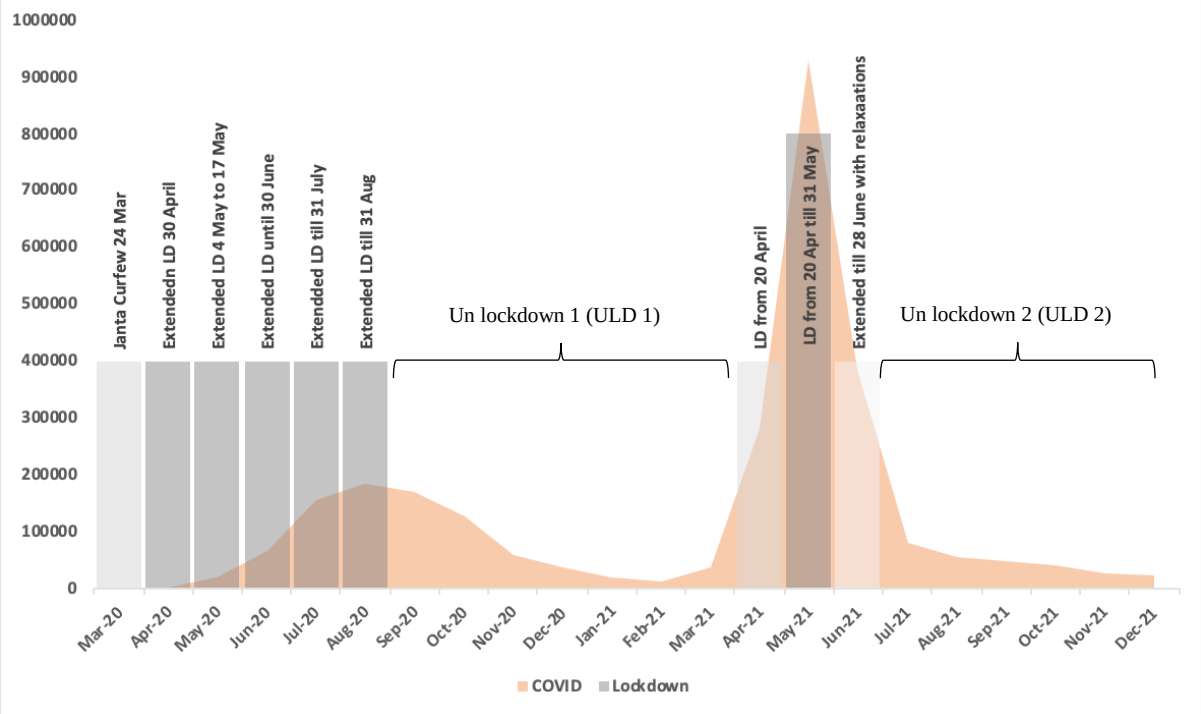
The first wave (W1) of COVID-19 observed between May and October 2020 for six months period. During this wave, 719864 (26.2%) of confirmed cases reported. The highest number of cases, 181817 reported in W1 August 2020, unlike the highest (W1 peak) observed in September 2020 in the country[15]

b. Second wave (W1):

The second wave (W2) of COVID-19 lasted for four and half months from 1 March till 14 July 2021. During this wave, 1674772 (61%) of confirmed cases reported. The highest number of cases (929754) reported in May 2021

Comparing the two waves, the W1 existed longer than the W2, however the number of reported cases was three times higher in the W2 than the W1.

Figure 3: Phases of lockdown and COVID in state Tamil Nadu from March 2020 to December 2021



c. Lockdowns:

To mitigate the spread of COVID-19 infection, the state implemented lockdowns to restrict the movement of the people and non-essential activities. The lockdowns are depicted as block shading in Figure 2

[15] https://www.worldometers.info/coronavirus/country/india/

- In 2020, Tamil Nadu was under lockdown from March 25 to May 31, which was extended several times with some relaxations till 31 August 2020.[16] The study considered the first lockdown (LD1) period from 25 March to 31 August 2020 (Five months 7 days). The un-lockdown/ relaxation (ULD1) period from September 2020 till before to the announcement of lockdown on 20 April 2021 (7 months 19 days).
- In 2021, Tamil Nadu went into lockdown again on 20 April due to a surge in COVID-19 cases. The lockdown was initially for two weeks and was later extended till May 2021.[17] The study considered the second lockdown (LD2) period from 20 April till May 2021 (One month 9 days). The un-lockdown/ relaxation (ULD2) period from June 2021 till December 2021 (7 months).

In addition to the lockdowns, other measures such as curfews, restrictions on travel and gatherings, and closure of non-essential services were also imposed to control the spread of the infection. In addition, district administrations have identified containment zones (Red zone, Orange zone) where activities were limited from No activity to minimal activity and green zones where there was no transmission of COVID-19 infection.

B. COVID-19 cases reported in state and districts

Tamil Nādu has 38 administrative districts, while the NTEP has 35 NTEP districts. For data analysis, 5 NTEP districts of Chennai (Chennai Central, North, South, East and West) were synthesized as one district and made a total of 31 NTEP districts. In line with NTEP's 31 districts, the COVID data of 38 administrative districts were synthesized to 31 districts.

An overview of COVID-19 cases across districts in Tamil Nadu in 2020 and 2021 is in the table presented in Annexure 3.

- In 2020, the state recorded 8,15,630 COVID-19 cases. Chennai (27.5%) was the worst affected district in Tamil Nadu. Other districts that reported high COVID-19 include, Kancheepuram, Coimbatore, Vellore, Tiruvallur and Salem.
    - Karur records the lowest (5184) and Chennai records the highest number of COVID- 19 cases (225109), median of 16247 and average of 26310 across the districts
- In 2021, the state recorded 19,29,800 COVID-19 cases. Again, Chennai (18%) was the worst affected district in Tamil Nadu. Other districts that reported high COVID-19 include Coimbatore, Kancheepuram, Erode, Vellore, Tiruppur, Tiruvallur and Salem.
    - Ramanathapuram records the lowest (14190) and Chennai records the highest number of COVID-19 cases (342228), median of 40301 and average of 62252 across the districts.

In addition, the study looked at the rate of COVID-19 cases based on the population data as per Census 2011 (see Annexure 3).

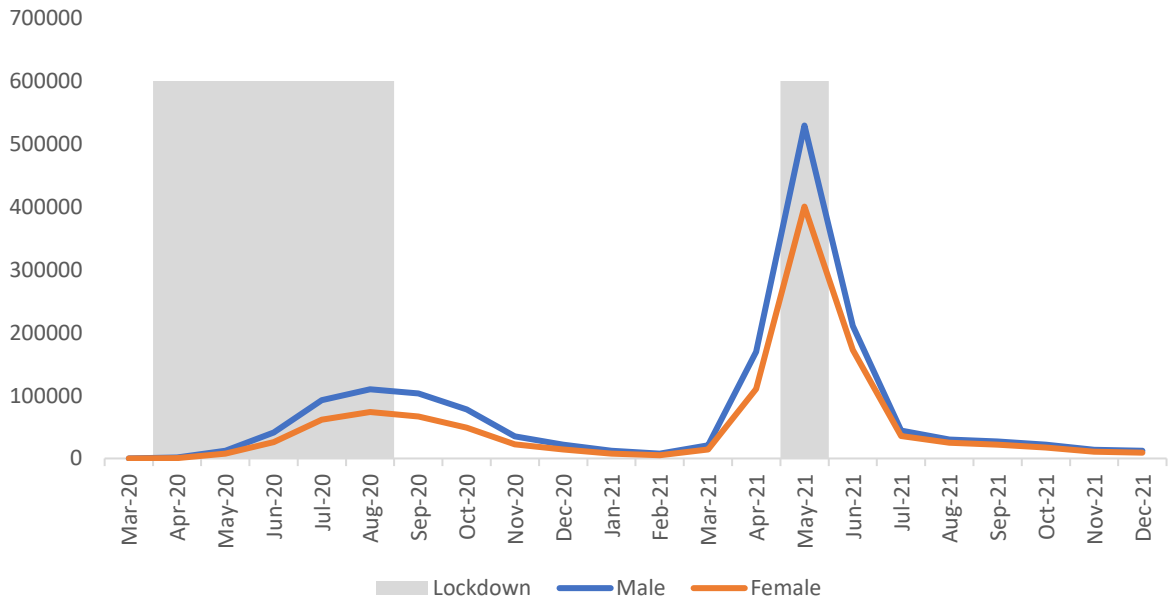
[16] Disaster Management Act, 2005 – COVID 19, complete lockdown enforced throughout the state, extended up to 31 August 2020. GO (Ms) No.396. https://cms.tn.gov.in/sites/default/files/go/revenue_e_396_2020.pdf
[17] Disaster Management Act, 2005 – COVID 19, complete lockdown enforced throughout the state, extended up to 31 May 2021. GO (Ms) No.386. https://cms.tn.gov.in/sites/default/files/go/revenue_e_386_2021.pdf

- In 2020, the state recorded 1126 cases per lakh population. Six districts (Chennai, Kancheepuram, Coimbatore, Theni, Villupuram and Tiruvallur) had higher COVID-rates than the state.
    - Chennai recorded the highest with 4844 cases per lakh population and Krishnagiri recorded the lowest with 408 cases per lakh population
- In 2021, the state recorded 2664 cases per lakh population. Six districts (Chennai, Pudukottai, Cuddalore, Erode, Virudhunagar and Tiruppur) recorded higher COVID rates than the state.
    - Chennai recorded the highest with 7365 cases per lakh population and Ramanathapuram recorded the lowest with 1048 cases per lakh population

C. COVID-19 and gender

COVID-19 affects people of all genders, but there have been some differences observed in terms of the impact of the virus on different genders. Studies have shown that men are more likely to experience severe symptoms and have a higher risk of death from COVID-19 than women.[18] This may be due to several factors, including differences in immune responses, hormone levels, and behaviours such as smoking and alcohol. The gender-disaggregated numbers of COVID infections are shown in Figure 4 below:

Figure 4: COVID-19 and gender in Tamil Nadu from March 2020 to December 2021



In 2020, 496166 (61%) men, 321788 (39%) women and 60 transgender persons reported. In 2021, 1099548 (57%) men, 830456 (43%) women and 27 transgender persons reported.

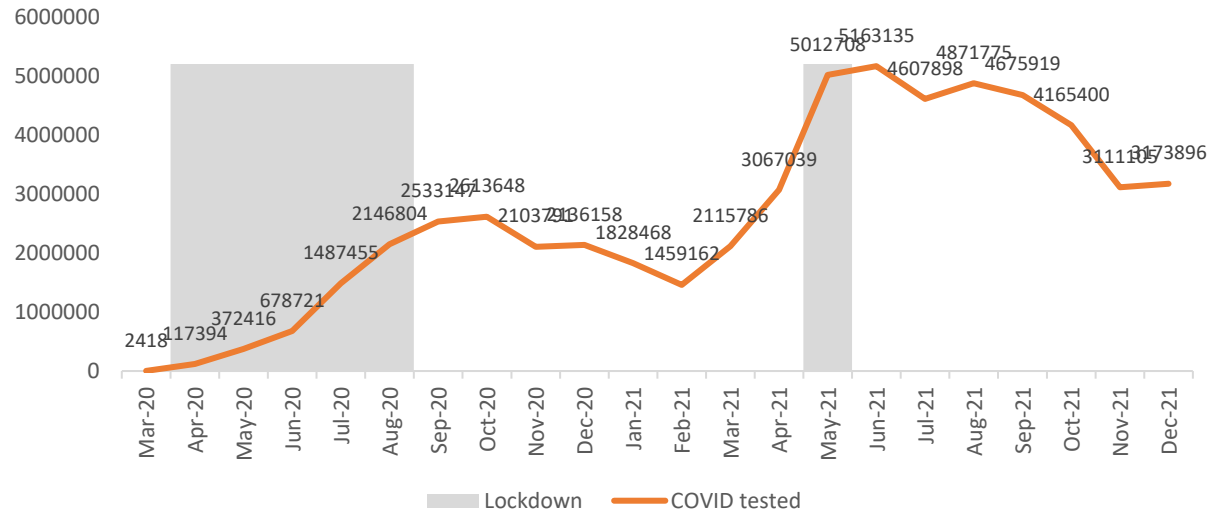
[18] Gender differences in patients with COVID-19: Focus on severity and mortality. https://www.frontiersin.org/articles/10.3389/fpubh.2020.00152/full

Additionally, the COVID-19 pandemic has had a disproportionate impact on women in other ways[19]. Women have been more likely to lose their jobs or have their income reduced due to pandemic-related economic impacts. Women also have had to bear a disproportionate burden of caregiving responsibilities for sick family members and children who are not able to attend school or daycare due to pandemic-related closures. This has resulted in increased stress, burnout, and mental health challenges for many women. Other studies have reported the severe impact of the COVID pandemic on transgender persons, as they faced even greater economic precarity and mental health challenges than during non-COVID times[20]

D. COVID-19 testing

COVID-19 testing in Tamil Nadu was conducted through various methods such as RT-PCR, rapid antigen testing, and Truenat testing. These tests were being carried out at government and private laboratories across the state. In addition, the government had set up several COVID-19 testing centers across the state to ensure that people could get tested easily at government hospitals, private hospitals, and mobile testing vans[21]. The Tamil Nadu government was also conducting door-to-door testing drives in high-risk areas[22] to identify and isolate COVID-19 positive cases early. This was being done to prevent the spread of the virus and ensure timely treatment for those infected.

Figure 5: COVID-19 testing in Tamil Nadu from Mar 2020 to Dec 2021



COVID-19 testing increased significantly over time since the first wave, the data shows that the COVID-19 samples tested in year 2021 were double the samples tested in year 2020. In early months of pandemic, COVID-19 testing was limited due to factors such as a shortage of

[19] Why COVID-19 is different for men and women. https://www.bbc.com/future/article/20200409-why-covid-19-is-different-for-men-and-women
[20] Impact of COVID-19 on Sex Workers and the Transgender Population in India. https://www.igi-global.com/chapter/impact-of-covid-19-on-sex-workers-and-the-transgender-population-in-india/281424
[21] In Tamil Nadu, vans to collect COVID-19 samples from patient's door step. https://www.deccanherald.com/national/south/in-tamil-nadu-vans-to-collect-covid-19-samples-from-patients-doorstep-824503.html
[22] Containment plan for large outbreaks. https://www.mohfw.gov.in/pdf/3ContainmentPlanforLargeOutbreaksofCOVID19Final.pdf

testing kits, limited laboratory capacity, time to establish the testing processes across labs, and a lack of awareness about the virus. However, as the situation evolved and the government ramped up efforts to control the spread of the virus, hence testing capacity in Tamil Nadu increased significantly. This increase in testing capacity has helped identify more COVID-19 cases, isolate infected individuals, and prevent the spread of the transmission.

Chennai, Kancheepuram, Vellore, Madurai and Coimbatore districts have reported higher numbers of COVID-19 testing in the state in 2020 and 2021.

E. COVID-19 bed capacity

As on 12 August 2022, bed capacity in the state based on the type of institution, Community health centres (CHC), COVID care centres (CCC) and integrated command and control centres (ICCC), presented in below table,

Table 5: COVID institutions, dedicated beds in Government and private sectors as on 12 August 2022

S.no	Type of institution	No. of COVID institutions	Total COVID dedicated beds	Govt COVID beds	Private COVID beds
1	CHC/CHO	1388	77069	37540	39529
2	CCC	245	35848	34487	1361
3	ICCC	427	6425	6425	0
Total		2060	119342	78452	40890

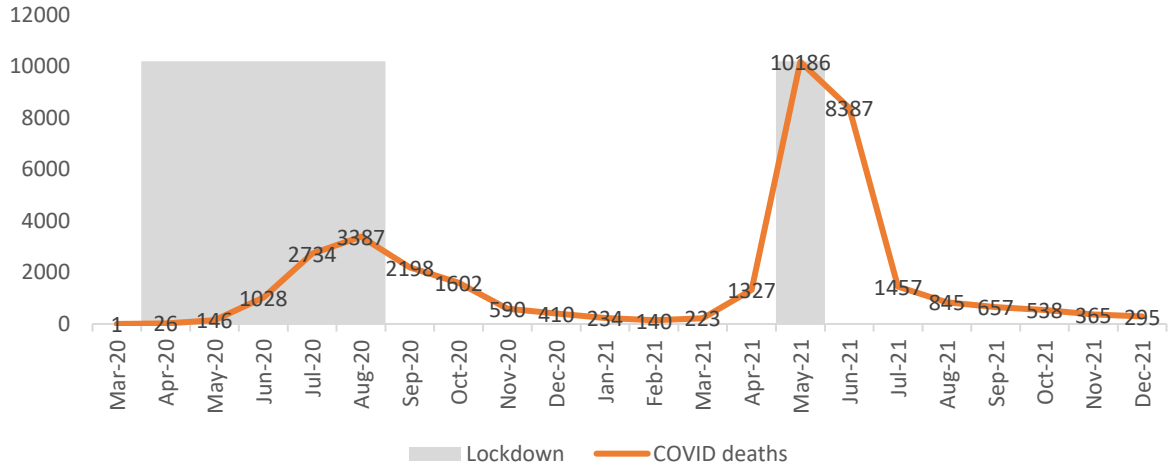
F. COVID-19 deaths

The state reported 36774 deaths due to COVID during 2020 and 2021. The deaths recorded in W1 (1 May – 31 Oct 2020) were 11095, highest in August 2020 (September 2020 for the country) . Similarly, the deaths recorded in W2 (1 March - 14 July 2021) were 21580, highest in May 2021. More number of deaths recorded in W2 compared to W1.

Chennai (23.5%) contributed to the highest number of COVID-19 deaths, while Sivagangai the lowest number (0.6%) of COVID-19 deaths in the state. Presented in Annexure 4.

The state has recorded the rate of 17 COVID-attributable deaths per lakh population in 2020 and 34 per lakh population in 2021. The rate of deaths was reported highest in Chennai, 87 per lakh population in 2020 and 100 per lakh population in 2021; and lowest 4 per lakh population in Dharmapuri and 7 per lakh population in Sivagangai districts. Presented in Annexure 5.

Figure 6: COVID-19 deaths in Tamil Nadu from March 2020 to December 2021



Multiple reasons have been cited for the higher death toll in the second wave, including the emergence of new, more transmissible variants of the virus, a higher number of cases overwhelming the healthcare system, and a shortage of oxygen and other essential supplies in some areas[23].

G. COVID-19 data limitations

While data on COVID-19 testing, cases, and deaths reported district wise in Tamil Nadu (March 2020 - December 2021) provide important insight about the effects of COVID, we were not able to access patient-wise data to study patterns associated with age, gender, area of living (rural, urban geographies), and facility wise data of COVID care centre and COVID testing centres (RT PCR, Rapid antigen kits and Truenat machines). Additionally, there could be variations in reporting of COVID cases and deaths in health systems across the districts.

Impact of COVID-19 on Tuberculosis in Tamil Nadu

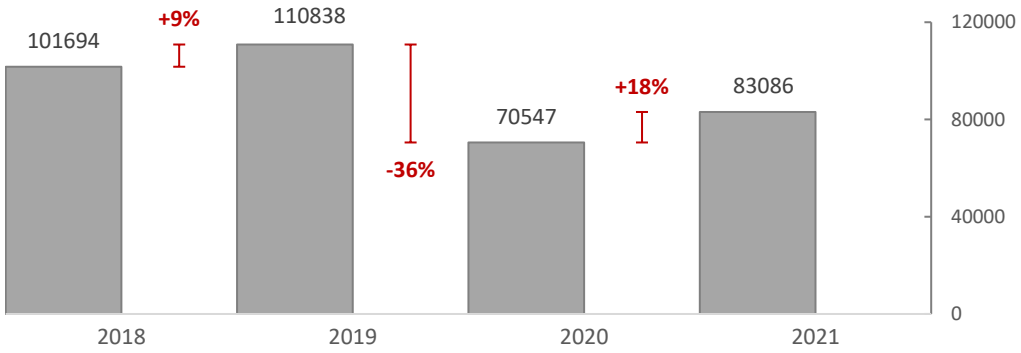
The COVID-19 pandemic had a significant impact on the TB control efforts worldwide. The disruptions caused by the pandemic have resulted in delays in TB diagnosis and treatment management[24]. To address the challenges, the National TB Elimination Program (NTEP) instituted an array of measures to ensure continuity of TB services during the pandemic. The secondary data analysis of the state and six study districts allows us to examine association between COVID-19 measures and TB notifications, diagnostics, treatment initiation and treatment outcomes. These findings are supplemented with qualitative findings from patients, providers, and stakeholder perspectives on TB care from six study districts.

[23] Consecutive hits of COVID-19 in India: The mystery of plummeting cases and current scenario. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8934068/
[24] The twin epidemics: TB and COVID-19 in India. https://link.springer.com/chapter/10.1007/978-981-16-7385-6_5

H. TB notifications in years 2018 – 2021

TB notification refers to the number of TB cases that are reported to the National TB Elimination program (NTEP) in a Nikshay portal. TB notifications include both new and retreatment cases, Drug Susceptible and Drug Resistant TB cases, TB cases reported to NTEP program by public and private healthcare facilities, laboratories and by community health workers. The notification process helps to ensure TB patients receive proper diagnosis, treatment care and helps to prevent transmission in the community.

Figure 7: Annual percent change of TB notifications in Tamil Nadu during 2018 – 2021



Tamil Nadu reported 101694 TB notifications in 2018, 110838 in 2019, 70547 in 2020 and 83086 in 2021. The number of TB notifications surged by 9% in 2019 compared to 2018 and then decreased during the COVID-19 (2020–2021). In comparison to previous years, there was a 36% decrease in 2020 and a gain of 18% in 2021. However, the number of TB notifications in 2021 did not reach to the levels of pre COVID-19 years (2018-2019).

A paired samples t-test showed that across districts, TB reporting decreased from 2019 to 2020 ($t = -6.15$, $p < .001$, $d = 30$) and also when Pre-COVID (2018, 2019) to COVID (2020, 2021) years combined, ($t = -7.05$, $p < .001$, $d = 30$). However, TB reporting increased from 2020 to 2021 ($t = 4.91$, $p < .001$, $d = 30$), presented in Annexure 6.

Wilcoxon rank sum tests showed the pattern of decline in notifications when Pre-COVID (2018, 2019) to COVID (2020, 2021) years combined, in moderate and low COVID burden districts ($p < 0.001$) and high COVID burden districts ($p < 0.05$). TB reporting increased from 2020 to 2021, in high COVID burden districts ($p < 0.05$), in moderate and low COVID burden districts ($p < 0.001$).

The same pattern is observed with the rate of TB notifications across districts,

A paired samples t-test showed that across districts, TB reporting decreased from 2019 to 2020 ($t = -11.35$, $p < .001$, $d = 30$) and also when Pre-COVID (2018, 2019) to COVID (2020, 2021) years combined, ($t = -11.40$, $p < .001$, $d = 30$). However, TB reporting increased from 2020 to 2021 ($t = 8.04$, $p < .001$, $d = 30$).

Figure 8: Quarterly percent change of TB notifications in Tamil Nadu during 2018 – 2021

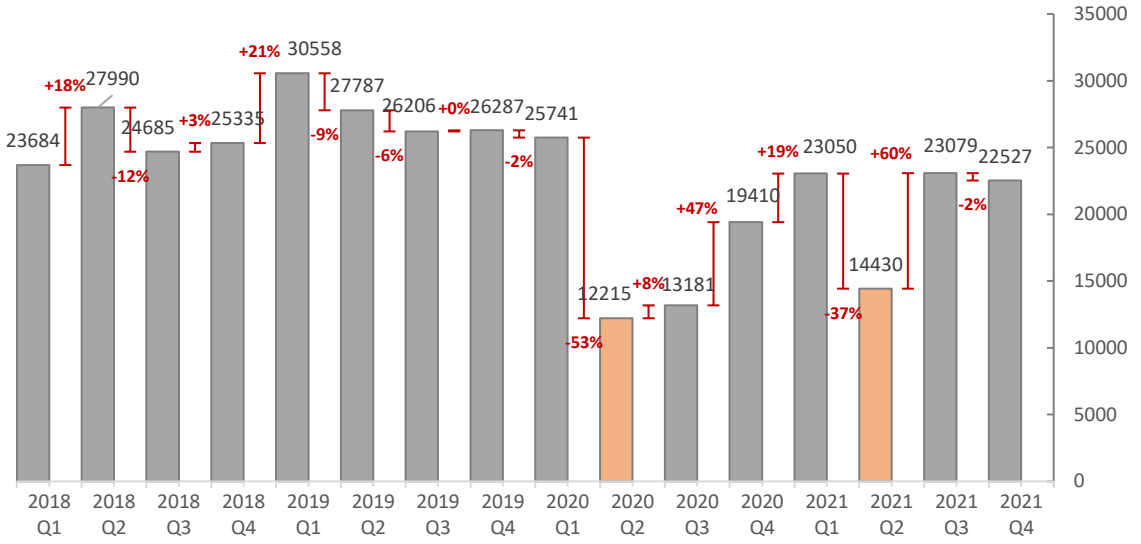


Figure 8 shows the quarterly trend in TB notifications. The state reported a quarterly average of 25,000 TB notifications prior to Q2 2020. As expected, to result from the nation-wide lockdown on 24 March 2020 (Janata curfew) and surge of COVID cases during W1, there was a 53% decline in TB notifications in Q2 2020. There was a gradual increase from Q3 2020 – Q1 2021 (74%) after Wave 1 and again a decline of 37% in Q2 2021 due to surge of COVID cases in W2 and a brief lockdown in May 2021. In contrast to gradual recovery after Wave 1, TB notifications immediately increased in Q3 2021 after Wave 2 and held steady in Q4 2021.

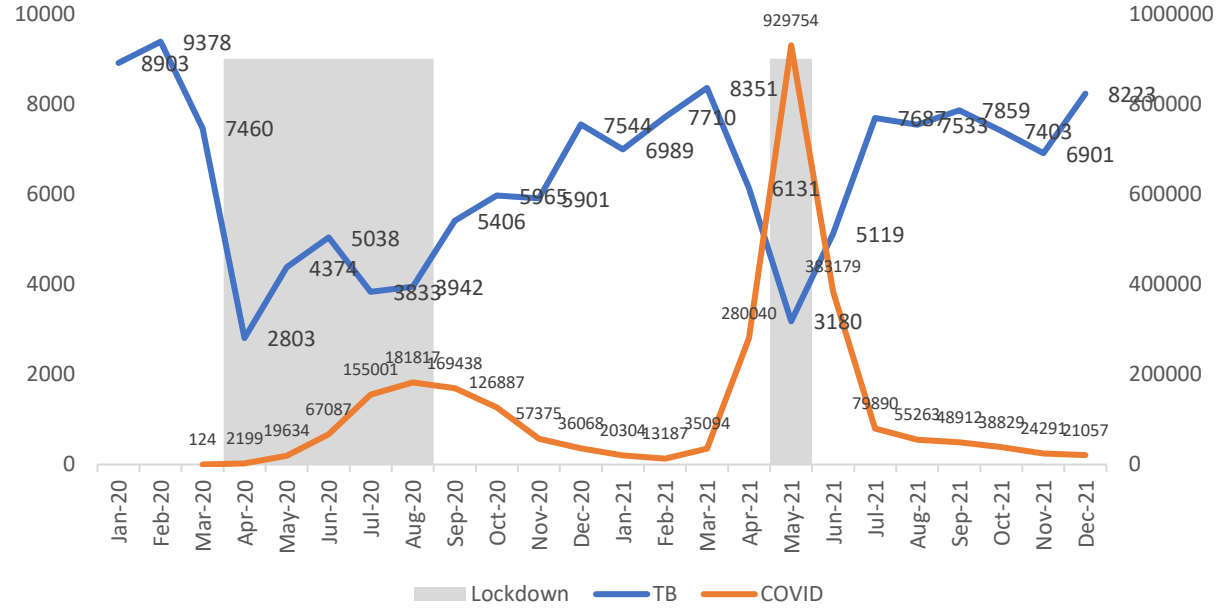
The six study districts showed similar patterns of decline during waves and steady progress of TB notification following the W1 and substantial increase in TB notification following the W2. In the study period, the lowest TB notification per quarter observed in Q2 2020 in Kancheepuram, Tiruchirappalli and Villupuram whereas the lowest TB notification was recorded in Q3 2020 in Coimbatore, Madurai and Dharmapuri (Annexure 6).

Key informants suggested the following reasons for the substantial and immediate increase in TB notification after W2:

- Applying the lessons learned from W1 and start of active case finding (ACF) campaign in the field in 2021
- Conducting targeted case finding in NCD clinics and bi-directional screening of COVID and TB cases at district hospitals and COVID care centres
- Following up with post-COVID patients. Contacting post-COVID patients from district hospitals and medical college hospitals who continued to experience symptoms and collecting samples from them to test for TB using NAAT. In Kancheepuram district, nearly 316 samples were collected, and 1.6% were diagnosed with TB
- Collecting samples from ILI (Influenza like illness) and SARI (Severe acute respiratory illness) in-patients, who already spent 7 days of time in the ward, with an assumption that patients are no more infectious
- MD-NHM issued instructions to collect CT scan reports from district hospitals and medical college and hospitals to identify any TB-related findings and contact patients for NAAT testing

- Home based TB sample collection services by the frontline workers, NTEP program staff and NGOs
- Case finding strategies in private sector by communication with providers through IMA, IAP, Lab, and pharmacist unions

Figure 9: TB notifications and COVID cases reported in Tamil Nadu from January 2020 to December 2021



There were declines in TB notifications during COVID waves (W1, W2) and phases of lock down restrictions (LD1, LD2) when COVID cases rose. However, the rank correlation is not statistically significant between TB notifications and COVID cases (Kendall's Tau = -0.298, $p > 0.05$). TB notifications increased following W1 and W2 periods, however this doesn't show a statistical significance in increase of TB notifications post wave periods (Kendall's Tau = 0.418, $p > 0.05$)

Annexure 7 shows the TB notification rates based on the population data (as per Census 2011). The rate of TB notifications was 140 per lakh population in 2018, and 153 per lakh in 2019, which decreased to 97 per lakh in 2020 and 115 per lakh in 2021 in state. The highest rate of TB notification over the years remained in Chennai.

Table 6, excerpted from Annexure 7, presents the district's rate of TB notifications which are higher than the rate of state TB notification of respective year in a descending order

Table 6: Districts show higher rate of TB notification than the state in respective years

S.No	2018 (Districts >= 140 per lakh population)	2019 (Districts >= 153 per lakh population)	2020 (Districts >= 97 per lakh population)	2021 (Districts >= 115 per lakh population)
1	Chennai	Chennai	Chennai	Chennai
2	Madurai	Madurai	Madurai	Madurai
3	Virudhunagar	Erode	Kancheepuram	Kancheepuram
4	Erode	Tiruchirappalli	Virudhunagar	Dindigul
5	Tiruchirappalli	Theni	Theni	Theni
6	Kancheepuram	Kancheepuram	Dindigul	Erode
7	Thanjavur	Virudhunagar	Sivagangai	Virudhunagar
8	Tuticorin	Ramanathapuram	Erode	Villupuram
9	Ramanathapuram	Thanjavur	Ramanathapuram	Thanjavur
10	Theni	Sivagangai	Thanjavur	Perambalur
11	Tirunelveli	Dindigul	Tuticorin	Sivagangai
12	Coimbatore	Tuticorin	Villupuram	Tiruchirappalli
13	Dindigul		Tiruchirappalli	
14			Coimbatore	

COVID-19 rates explained the pattern in TB notifications across districts ($r^2 = 0.37$, $p < 0.02$). The higher the COVID-19 reporting in the districts showed higher TB notifications in the district.

Annexure 8 tabulates the TB notification patterns and percentage annual change across 31 NTEP districts with COVID-19 in place during 2020 and 2021. Annexure 9 presents the quarter wise heat map of TB notifications across 31 NTEP districts.

- The majority of NTEP districts showed an increase in TB notifications between 2018 and 2019, with the exception of five districts - Krishnagiri, Tiruvallur, Madurai, Namakkal, and Virudhunagar.
- In 2020, TB notifications showed a decline by 36% (range of 24 - 47% across districts) compared to 2019 levels; and 18% increase in 2021 (range of 0 - 36% across districts) compared to 2020 in the state
- The progress made in TB notification in 2019 was disrupted with the advent of COVID-19 W1, and by the end of 2021, neither the state nor the districts TB notifications had increased to the levels of 2019.
- Notifications of TB cases were 139 per lakh in 2018, 151 per lakh in 2019 which lowered to 97 per lakh in 2020 and 114 per lakh in 2021 in the state.

The qualitative findings below corroborate the quantitative trend of TB notification declining with increase in COVID notification and suggest some reasons for the same in terms of health systems and service delivery.

Qualitative study key findings on decline of TB notifications during lockdowns

a) **Perceptions on detection of TB in the community and TB notification during the COVID pandemic.** There has been a decline in TB notifications during COVID-19 W1 and W2, the reasons for this decline are:

First, the diversion of healthcare resources towards COVID-19 response has impacted the routine screening and diagnosis of TB cases. Health system had to prioritize the treatment of COVID-19 patients, which have led to a reduction in the availability of healthcare personnel, laboratory services, and medical equipment needed for TB diagnosis and treatment.

> "…During the lockdown period, the general OPDs were not functioning, and we were not able to get any TB patients. Since there were no TB referrals from OPs and no activities like active case finding happened, the notification numbers have gone down to a large extent. This was the case in the entire state and not only in Kancheepuram district" (HCP 1).

> "Due to increased number of COVID cases in the second wave, all the departments were converted as COVID departments. The second wave was more critical. That time we had less concentration on other cases. We did not have enough space. So, we then referred TB patients to other hospitals like Walajabad and nearby PHCs. There they arranged staff to care for them. Beyond this we don't know what happened to them (HCP 6)

> "During the first lockdown, if anyone had cough or cold, we always thought of COVID only. We only took swabs for COVID testing and not sputum for TB. We were not able to do TB related work and we never thought of TB at all. We did not have time for TB patients since we were all busy with COVID related work. We couldn't even follow up the Antenatal mothers and didn't provide vaccination for children. Even in PHCs and GH, the antenatal care and vaccination of under 5 children got affected. Recently only we were able to do our routine work without any interruption" (HCP 10). "…Adding to this, 4 of our 7 LTs were deputed for the COVID work, which led to more difficulties in running the program (HCP 9).

A few presumptive TB patients reported that owing to the COVID pandemic they were not able to get a proper diagnosis of their health problem when they visited the government hospital as the focus of the hospitals was entirely on managing the COVID pandemic. Not receiving feedback regarding their test results were also cited by few patients.

"Since it was Corona time nobody had any proper answer [for my condition]. They were only giving me medicines and glucose. Then the doctors were also affected with Corona. We could not see the doctors be it here or at the GH",(Pt. Pre-TB1).

"I don't know even now. I came for consultation for cough and cold issue, so I thought only after these tests, they would prescribe the medicines. They didn't tell me whether it's for fever, or sugar or BP, neither did I ask", (Pt. Pre-TB3).

b) Secondly, fear of exposure to COVID-19 in healthcare settings has discouraged people from seeking medical care for TB symptoms. This resulted in delays in TB diagnosis and treatment, which contributed to the decline in TB notifications.

> "There was not much change in TB notifications during COVID time. Only certain amount of lack was there. Since patients weren't willing to give samples, samples could not be received. ..... They were also afraid of getting COVID. They thought if they come, they will be subjected to COVID test also..."

> "…Everything was under lockdown, and no one could move around. The other reason was fear of getting infected with COVID and being isolated in the hospital. Everyone had that fear including me, because of which many people did not want to go anywhere near a hospital" (NTEP)

> "We didn't know how to handle the situation during the first wave, half of the doctors were affected while working with COVID patients. We were also in fear of COVID" (HCP 3)

> "Patient will tell us that he is getting phlegm. But their family members will not allow him to give samples. They were afraid that if it is Corona, the patient will be taken to a different place for isolation…"(HCP)

c) Different opinions shared by the HCPs for fewer TB cases reported during lock downs,

i) The implementation of public health measures such as lockdowns, physical distancing, and reduced mobility have decreased the transmission of TB.

> "Yes, I do believe TB notifications had gone down during COVID, this is because the patients would not have approached the hospital even if they had symptoms. I also think that somebody in each household would have got affected by COVID and they would need to isolate themselves. Because of this the whole family must be quarantined and another reason would be the transport problem....", (HCP 12)

> "....Maybe patients were wearing mask all the time, hence co-infection decreased. Maybe that could have been a reason for less number of active cases. Everyone was asked to take adequate, nutritious food. Maybe that time only they were having healthy food and no one's immunity dropped. Maybe they didn't have reactivity to their older things. Maybe that could have been the reason also", (MO-TB)

ii) Restriction in transportation may have resulted in patients' non-accessibility to the health care. Hence patients did not turn up to healthcare, which contributed to the decline in TB notifications.

> "Even we faced a lot of difficulties commuting to the hospital during the COVID time. Despite travelling in the government vehicle with the TN government board, the police stopped us and asked a lot of questions. Only after showing our identity cards, they allowed us to pass" (HCP).

Patient demographics in TB notifications

Table 7: TB and gender

Gender	2018		2019		2020		2021	
Male	70752	70%	76675	69%	48375	69%	55896	67%
Female	30861	30%	34041	31%	22143	31%	27161	33%
Transgender	81	0%	121	0%	29	0%	29	0%
Total	**101694**	**100%**	**110837**	**100%**	**70547**	**100%**	**83086**	**100%**

The study observed decrease in TB notifications in both genders in 2020.

- Across the study period, approximately one-third of TB notifications are accounted by women. Among the six districts studied, women make up between 25% to 33% of the cases.
- No variation seen across proportion of gender reporting of TB cases during COVID years.
- In comparison to the Pre-COVID years, a paired samples t-test showed that across districts, males showed significant decline ($t = -7.02$, $p < .05$, $d = 30$) in TB notification in COVID years

Table 8: TB by age groups

Age	2018		2019		2020		2021	
0-14	4968	5%	5854	5%	2955	4%	2723	3%
15-30	20140	20%	21028	19%	14566	21%	16451	20%
31-45	28667	28%	30014	27%	19290	27%	21975	26%
46-60	32411	32%	35799	32%	23013	33%	28123	34%
>60	15508	15%	18143	16%	10723	15%	13814	17%
Total	101694	100%	110838	100%	70547	100%	83086	100%

The study did not find any proportionate variation in TB notifications across different age groups during the COVID period. In general, the order of frequency of TB cases based on age groups was as follows: 46-60 years, 31-45 years, 15-30 years, above 60 years, and 0-14 years, with the highest number of cases in the 46-60 age group and the lowest in the 0-14 age group.

In comparison to the Pre-COVID years, a paired samples t-test across the districts, age groups 1 – 14 ($t = -4.94$, $p < .05$, $d = 30$), 15 – 30 ($t = -5.47$, $p < .05$, $d = 30$), 31 – 45 ($t = -6.61$, $p < .05$, $d = 30$), 46 – 60 ($t = -6.90$, $p < .05$, $d = 30$) and > 60 ($t = -6.34$, $p < .05$, $d = 30$) years showed a significant decline in TB notification in COVID years.

Table 9: Comparison of demographic features with periods of interest :Wave 1 2020, Wave 2 2021 and its corresponding reference periods in 2019

(Wave 1 2020 : 1 May – Oct 2020 and Wave 2 : 1 Mar - 14 July 2021)

Characteristics	W1 2019 (Ref)	W1 2020	% change in 2020	W2 2019 (Ref)	W2 2021	% change in 2021
Total TB cases	52431	28558	-46%	42325	26243	-38%
Age group						
1 - 14 years	2636	992	-62%	2183	886	-59%
15 - 30 years	10050	6229	-38%	8177	5624	-31%
31 - 45 years	14207	8110	-43%	11512	7062	-39%
46 - 60 years	17120	9316	-46%	13694	8693	-37%
>60 years	8418	3911	-54%	6759	3978	-41%
Gender						
Male	36419	19365	-47%	29374	17595	-40%
Female	15956	9183	-42%	12905	8639	-33%
Transgender	56	10	-82%	46	9	-80%

- Study observed, 46% decline of TB cases during W1 2020 compared to the reference period in year 2019 ($t = -5.47$, $p < 0.05$, $d=30$). Similarly, a 38% decline observed in W2 2021 compared to the reference period in year 2019 ($t = -7.17$, $p < 0.05$, $d=30$).

- There is a significant decline observed across the districts for all age groups and gender ($p < 0.05$) between Wave period (W1, W2) and corresponding reference period in year 2019.

I. TB notifications in public and private health sectors

TB notifications refer to the number of TB cases that are reported to the NTEP program by both public and private health care facilities. Each district has TB units that typically correspond to health blocks. These TB units oversee public sector PHIs and private sector healthcare establishments such as hospitals, clinics, laboratories, and pharmacies. The public sector PHIs consist of medical colleges, district headquarters hospitals, sub-district hospitals, block primary health centers, primary health centers, and health sub-centers.

Table 10: TB notifications based on type of health facility in Tamil Nadu

	No. of TB cases			
Type of health facility	**2018**	**2019**	**2020**	**2021**
Public PHIs	75614 (74%)	82335 (74%)	54024 (76%)	64534 (78%)
Private pharmacies	3405 (3%)	2262 (2%)	499 (0.7%)	270 (0.3%)
Private hospitals & clinics	20529 (20%)	22266 (20%)	11090 (16%)	12686 (15%)
Private labs	2146 (2%)	3975 (3%)	4934 (7%)	5596 (7%)
Total	101694	110838	70547	83086

Overall, public sector PHIs contribute three fourths of TB notifications and one-fourth by the private sector - hospitals, clinics, pharmacies, and labs. However, there are sector- and facility-wise differences in proportionate TB notification observed during 2020 and 2021.

- Public sector reporting increased by 2-4% compared with private sector in 2020 and 2021
- Notifications in private sector declined by 1-2% in pharmacies and 4 – 5% in private sector hospitals and clinics, and increased by 4% in private labs during 2020 and 2021

Public PHIs: A paired samples t-test showed that across districts, TB reporting from public PHIs decreased from Pre-COVID (2018, 2019) to COVID (2020, 2021) years, ($t = -9.1$, $p < 0.05$, $d = 30$). However, TB reporting from public PHIs increased from 2020 to 2021 ($t = 4.14$, $p < 0.05$, $d = 30$).

Private hospitals and clinics: A paired samples t-test showed that across districts, TB reporting from private hospitals and clinics do not show any significant variation from Pre-COVID (2018, 2019) to COVID (2020, 2021) years, ($t = 0$, $p > 0.05$, $d = 30$). However, TB reporting from private health facilities increased from 2020 to 2021 ($t = 2.13$, $p < 0.05$, $d = 30$).

Private labs: A paired samples t-test showed that across districts, TB reporting from private labs show significant increase from Pre-COVID (2018, 2019) to COVID (2020, 2021) years combined, ($t = 2.18$, $p < 0.05$, $d = 30$). This was evidently seen across the three study districts, Kancheepuram, Coimbatore and Tiruchirappalli in the increase of number of labs reporting as well as number of patient notifications.

Private chemists: A total of 29 out of 31 NTEP districts (except Cuddalore and The Nilgiris) reported TB notifications in years 2018 and 2019 (Pre-COVID) and during 2020 and 2021(COVID), only 19 out of 31 NTEP districts reported TB notifications. A paired samples t-test showed that across 18 districts, TB reporting from private chemists decreased from Pre-COVID (2018, 2019) to COVID (2020, 2021) years, ($t = -4.21$, $p < 0.05$, $d = 17$).

Private to public sector patient referrals: Also, the patient referrals from private to public sector across districts increased from Pre-COVID (2018, 2019) to COVID (2020, 2021) years ($t = 5.2$, $p < 0.05$, $d = 30$).

Key informants from the public sector suggested the proportionate increase in the public sector TB notifications in 2020 and 2021 (COVID-19) compared to the pre-COVID years of 2018-2019 due to the

a) Installation of additional Truenat machines in Tuberculosis Units (TUs) at sub-district levels across the districts
b) ACF campaigns in the districts in 2021
c) Increase in presumptive TB / ILI/ SARI/ COVID patients testing across all testing centres
d) Referrals of private sector presumptive TB cases to public facilities

However, the change was not uniform across the district, where in a few TUs reported lesser TB case detection due to absence of lab personnel and NAAT testing machines during lock downs. During lockdown 1 (LD 1), lab personnel (LTs and STLS) were assigned to the COVID work and during lock down 2 (LD 2), most of the lab staff were affected with COVID, hence staff were placed on rotation duties for staff management. Additionally, lab personnel positions remained unfilled/ vacant at few TB units.

In districts with a substantial private sector presence, increase in TB notifications was attributed to the effective strategies implemented by the program, such as

a) Communications sent to all private sector practitioners through IMA, IAP, lab and pharmacist unions to notify TB cases
b) Onsite visits to private facilities by District TB Officers (DTO) and NTEP staff has led to increase in the private sector notification, including diagnostic labs (especially in Dharmapuri)
c) Pathology and Radiology labs reporting cases improved in 2020 and 2021. Among the study areas, districts with larger private sector such as Coimbatore, Kancheepuram and Tiruchirappalli reported increase of labs reporting TB cases.

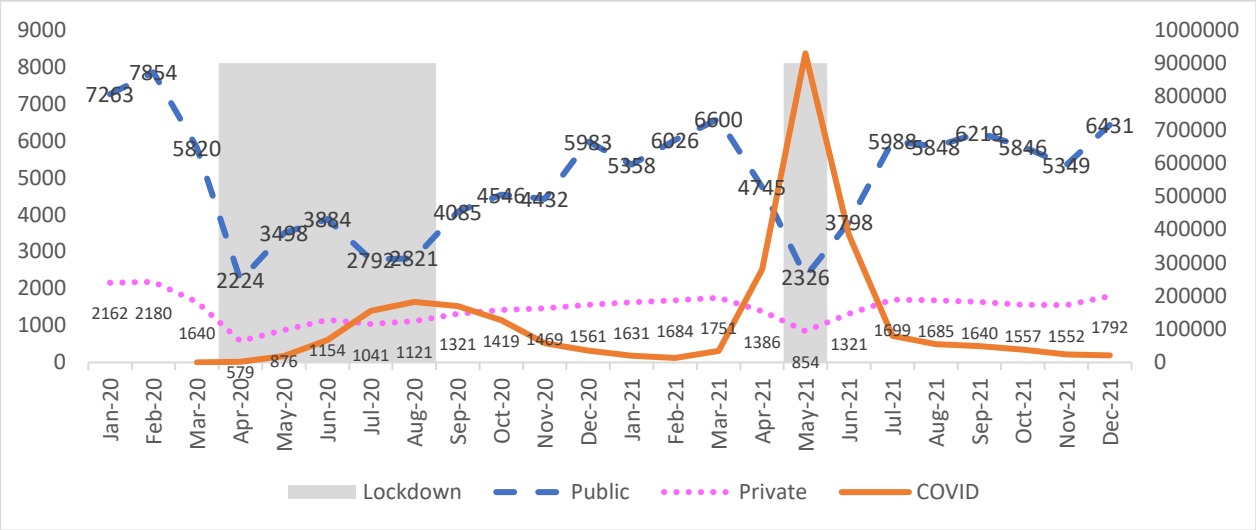
Table 11: Health facilities registration status and facilities that have notified at least one TB patient from 2018 to 2021*

Type of health facilities	2018		2019		2020		2021	
	Health facilities registration status	Facilities that have notified at least one TB patient	Health facilities registration status	Facilities that have notified at least one TB patient	Health facilities registration status	Facilities that have notified at least one TB patient	Health facilities registration status	Facilities that have notified at least one TB patient
Public PHIs	2630	1870 (71%)	2630	1488 (56.5%)	2638	1286 (49%)	2677	1288 (48%)
Private hospitals & clinics	18732	1965 (10%)	18732	2348 (12.5%)	19252	2015 (10.5%)	17553	2159 (12.3%)
Private labs	2513	320 (13%)	2513	669 (26.6%)	2922	733 (25%)	3022	657 (21.7%)
Private pharmacies	3298	318 (10%)	3298	170 (5.2%)	3832	84 (2.2%)	4197	43 (1%)
Total public and private	24543	4473 (18%)	24543	4675 (19%)	26006	4118 (16%)	24772	4147 (17%)

*Reference: Nikshay TB notification register for 2018 and India TB reports for 2019, 2020 and 2021. Total health facilities registration status was not available for 2018 in India TB report, hence the registration status of 2019 was considered.

Of the nearly 4000 health facilities diagnose and report TB cases every year in the state, one-third of facilities reported are from PHIs and two-thirds from heterogenous private sector. The study observed the number of facilities (PHIs, private hospitals and clinics, and pharmacies) reporting TB reduced in the COVID years whereas labs notified at least one patient increased in the COVID years.

Figure 10: TB notifications by public and private sectors in 2020 and 2021



The graph shows declines in TB notification during lockdowns, W1 and W2 in both the public and private health sectors. The trend of decline and rise is similar in public and private health sectors during 2020 and 2021. The rank correlation is statistically significant at $p < 0.0001$ (Kendall's Tau = 0.86)

Table 12: Wave 1 2020, Wave 2 2021, and its corresponding reference periods in 2019 (Wave 1 2020 : 1 May – Oct 2020 and Wave 2 : 1 Mar - 14 July 2021)

Characteristics	W1 2019 (Ref)	W1 2020	% change in 2020	W2 2019 (Ref)	W2 2021	% change in 2021
Health sector						
Public	39264	21626	-45%	31304	20157	-36%
Private	13167	6932	-47%	11021	6086	-45%

In comparison of W1 and W2 with 2019 reference periods, notifications from the public and private sectors decrease during wave period. A paired samples t test showed that across districts, notifications reporting from the public sector declined ($t = -8.08$, $p < 0.05$, $d = 30$) and private sector decline ($t = -3.24$, $p < 0.05$, $d = 30$) between wave periods and its corresponding reference period in 2019.

Qualitative study key findings from the program staff, patients, and providers on treatment case at private health care facilities–

The Public Private Mix coordinator (PPM Coordinator) of NTEP program staff stated that there were no new TB cases being seen during the pandemic and indicated that he would perhaps have seen only about 2 – 3 TB cases. He also said,

"All the private clinics were closed, very few doctors opened their clinics, maybe one doctor out of ten, opened the clinic. During that time, I must have seen only 2 to 3 cases. On an average, monthly, I would see 10 - 15 patients but during COVID time we received only 2-3 cases (HCP 3 PPM, NTEP).

“The PPM coordinator directly meets the private doctors on a regular basis to know whether they have diagnosed any new TB patients and follow those patients regularly. If there are any defaulters among the private patients, then the PPM coordinator will report it to the treating physician immediately. After this, the physician will make sure that the patient takes the medicines properly. Sometimes, when they are busy and not able to follow them up then they will let us know and our PPM Coordinator will regularly follow the private patients to know whether they have got enough medicines and taking it regularly”,

The Tuberculosis Health Visitor (TB-HV) was of the opinion that many patients with symptoms of cough and cold would have sought care from private doctors/clinics and may not have gone to the govt hospital. He further said,

“Though many had TB symptoms they went to concerned doctors for cough and cold without knowing. After recovering from COVID only many patients came and started registering”, (HCP 4,TBHV CHC-Rural NTEP).

The Rural VHNs also spoke of similar issues. The fear in the community about possibly being infected with COVID and of being quarantined thereof was very intimidating, as a result people tried to conceal their symptoms. Some even sought care from private doctors. As described in an FGD,

“We have asked the patients to check whether they have cold and cough, but they won’t reveal it to us because they were scared that we will diagnose them as COVID positive. They know that if they are tested positive then they will be admitted and quarantined from family for 15 days and were not willing for it. Instead, they visited the private hospitals where they will get the medicines for the complaints. Usually they will tell us that they have cold and need medicine, but nowadays they are very scared to tell us. For TB treatment, people still go to the private hospitals, spent money for treatment because they think that their diagnosis will be kept confidential over there”,(HCP 5, FGD-rural VHN).

The private doctor who was interviewed stated that many private clinics remained closed during the pandemic. In other instances video consultations were also provided. This doctor reported carrying out video consultations with his patients and stated that those with symptoms suggestive of TB were asked to undergo an X Ray. He said,

“Most of the time, with X Ray findings we found patients whether it is of COVID or TB. Majority of the time, treatment was initiated based on the X-ray finding, and sometimes, if it was a lymph node, we sent it to FNAC. Ninety percent of the time, with the X-Ray, I have made the diagnosis or sometimes patients thought because of the cough, it might be a COVID and instantly taken a CT scan, with the CT picture I found out, it is not a COVID but it is a TB”, (HCP 16, Private Doctor).

The doctor also described the challenges in obtaining a sputum test from suspected patients and said, “Yes, there was a challenge in the sputum sample collection. Most of the places were not getting sputum samples from the patients as it is contagious due to COVID, but not because of tuberculosis. So in GH hospital also we faced a problem, most of the time they didn't do Sputum AFB or Gene-Xpert testing”, (HCP 16, Private Doctor)

The doctor also reported that once he identified a patient as having TB he would mostly refer them to the government hospital for further management as obtaining TB drugs from private

pharmacies was difficult. However, once referred he rarely ever received any feedback on the patient's progress,

"Most of the times I refer them to the government sector, a lot of these patients won't take the drugs properly, also the drugs are not available in private pharmacies. The only thing is I am not getting any feedback, today I sent three or four patients, every week I send around five patients but once I send, there won't be feedback ....I think that the concept of government private partnership is not doing good ... I'm not concerned about whether they are referring to another place but I do want feedback on whether the patient is getting benefitted", (HCP 16, Private Doctor).

Describing the protocol that was followed for detection of TB cases during the pandemic he said,

"During COVID, patients with cough, cold and other TB symptoms were referred here for CBNAAT. An RT-PCR test for COVID will be taken first. If the patient is negative, a TB test will be taken. If the patient is positive for COVID, TB test will be done only after 14 days. This was the protocol followed from January 2021 for about nine months", (HCP 4,TBHV CHC-Rural NTEP).

J. Drug sensitive and drug resistant TB

TB disease is classified into drug sensitive and drug resistant depending on its response to anti-TB drugs. Drug-sensitive (DS) TB is a form of TB that can be treated with first line anti-TB drugs such as Isoniazid, Rifampicin, Ethambutol, and Pyrazinamide. Drug-resistant TB is a form of TB that is resistant to one or more of first line anti-TB drugs. DS TB cases included both newly identified cases and previously treated cases which experienced post-treatment failure or relapse, loss to follow up or any other reasons,

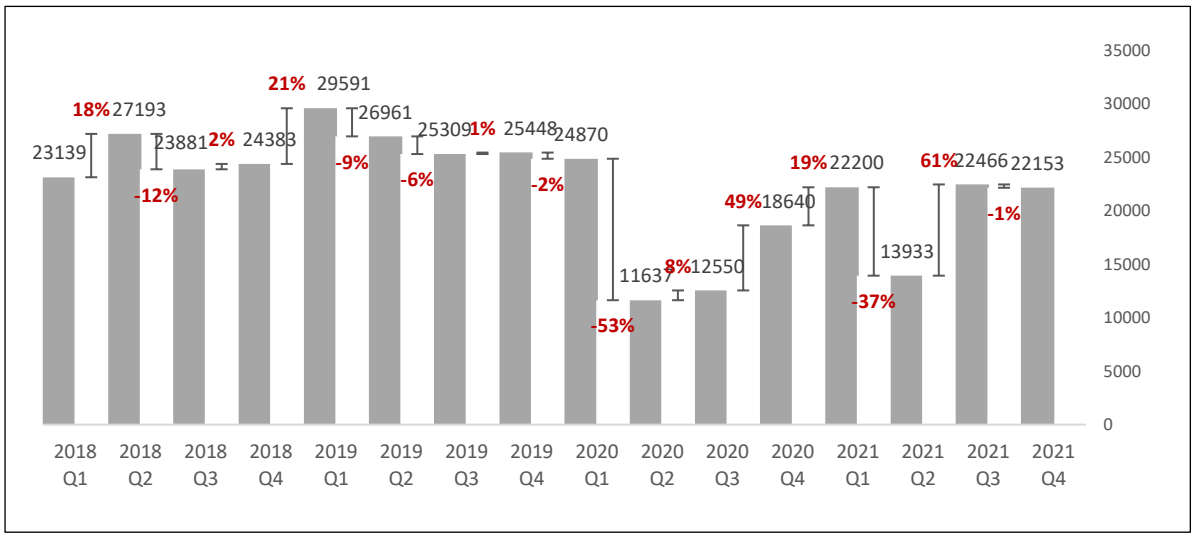
Table 13: Type of TB cases – New, Retreatment and Drug resistant TB

Type of case	2018		2019		2020		2021	
New (DS TB)	87217	86%	96738	87%	60146	85%	72739	88%
Retreatment (DS TB)	11379	11%	10571	10%	7551	11%	8013	10%
Drug resistant TB	2871	3%	3494	3%	2849	4%	2334	3%
Total	101467	100%	110803	100%	70546	100%	83086	100%

The study observed decline in number of both DS TB and DR-TB cases during COVID years. A paired samples t test showed that across districts, new cases ($t = -6.86$, $p < 0.05$, $d = 30$), retreatment cases ($t = -4.58$, $p < 0.05$, $d = 30$) and drug resistant TB cases ($t = -2.94$, $p < 0.05$, $d = 30$) showed a significant decline from Pre-COVID to COVID years.

However, there is an increase seen across study districts from 2020 to 2021, new cases ($t = 4.86$, $p < 0.05$, $d = 30$), retreatment cases ($t = 2.75$, $p < 0.05$, $d = 30$) and drug resistant TB cases ($t = -2.49$, $p < 0.05$, $d = 30$)

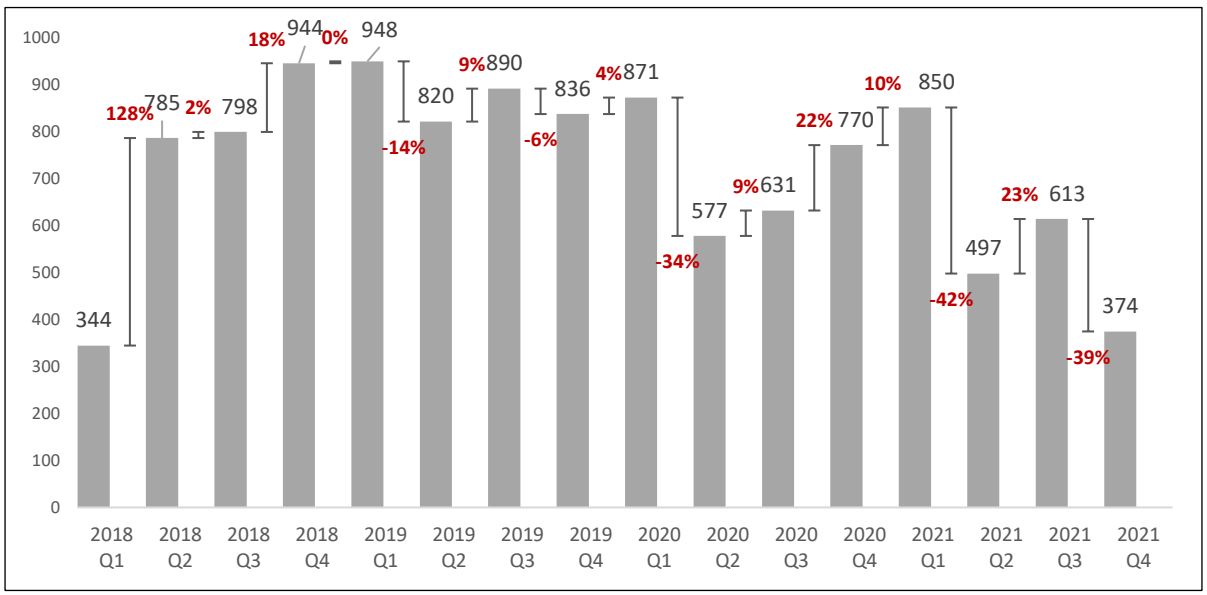
Figure 11: Quarter-wise percent change of Drug sensitive TB notifications in Tamil Nadu during 2018 – 2021 years



Data shows DS TB followed the similar pattern of overall TB notifications reported in the state. DS TB contribute to 96% of overall TB cases.

As a result of the effective strategies implemented by the NTEP program in the districts, there was an improvement in the detection and treatment of DS-TB cases. Following the lifting of COVID-19 restrictions and lockdown measure, people were able to access healthcare services, which resulted in more timely investigations and reduced delays in diagnosis. This led to an increase in the number of DS-TB cases that were identified and treated promptly.

Figure 12: Quarter-wise percent change of Drug-resistant TB notifications in Tamil Nadu during 2018 – 2021 years



Unlike the successive increase of DR-TB cases following the W1 period, there is an apparent decrease of DR-TB cases in the post W2 period between Q3 and Q4 2021 (-39%).

A paired samples t test showed that across districts, DR-TB cases among males ($t = -3.66$, $p < 0.05$, $d = 30$), showed a significant decline, whereas DR-TB among females do not show significant decline ($t = -1.13$, $p > 0.05$, $d = 30$) from Pre-COVID to COVID years. There is no significant variation observed in DR-TB cases across the age groups. In general, the frequency of DR-TB cases reported in age groups in descending order, 41-50, 51-60, 31-40, 21-30, > 60, 11-20 and 1-10.

Qualitative study key findings on drug resistant TB management

The JDHS described the challenges they faced owing to poor adherence by patients. Patients who were irregular in taking their TB medication owing to fears of side effects ran the risk of drug resistance which in turn exacerbated the risk of disease transmission. To guard against this she described that they will now need to further strengthen contact tracing activities which entailed,

"we need to do contact tracing for all TB patients since they can spread the disease to others easily. It is even worse if the patient is having drug resistant TB and I also feel that drug resistance would have developed among many TB patients as they found it very difficult to get the drugs and missed taking TB drugs for a few days during the pandemic", (HCP 2, JDHS).

A Private provider reported referring DRTB patients to government hospitals as such patients do not always take their medication properly thereby giving rise to drug resistance. The drugs they needed were also not available in the private sector. Describing the situation he said,

"Ninety percent of my TB patients would be referred to the public sector only and definitely DR-TB patients, as there were no DR-TB drugs available in the market"

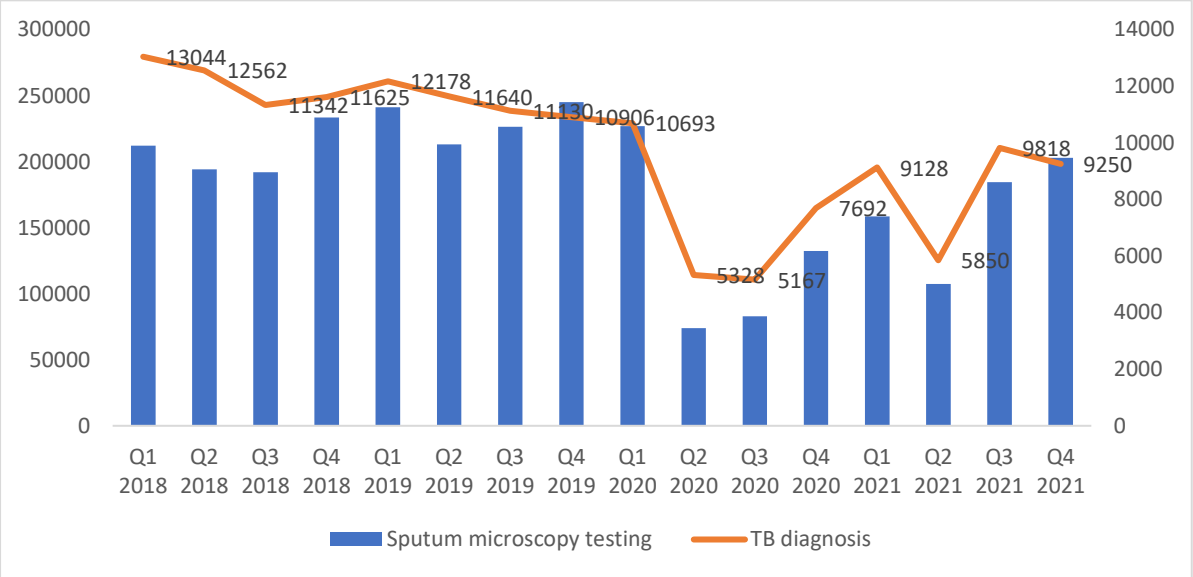
K. Presumptive TB testing and TB diagnosis

Sputum microscopy and NAAT (CBNAAT or Truenat) procedures are largely utilised for a presumptive TB testing under National TB Elimination Program (NTEP).

According to the study published by the Tamil Nadu, State TB Cell in 2022[25] "TB case finding in Tamil Nadu has undergone a paradigm shift in the last 7 years. To decentralize the availability of TB diagnostic services, a 137% increase in the number of DMCs was completed in 2018 – the number was increased from 837 to 1984. Nearly 75% of the public sector health facilities (1984 out of 2678) in the state are DMCs. With the introduction of WHO-recommended molecular diagnostics (WRMDs) for the diagnosis of TB since 2016, the laboratory system for high-quality TB diagnosis and drug resistance testing has expanded rapidly. This expansion of molecular diagnostics occurred in 3 rounds from 2016 to 2019 with supply of GeneXpert CBNAAT machines by the Central TB Division. Subsequently, Truenat MTB/MTB Rif machines were supplied from the third quarter of 2020 onwards. Initially, the eligibility for presumptive TB using molecular diagnostics was limited to PLHIV. Subsequently, in 2017, it was decided to expand the eligibility to key populations such as extra-pulmonary TB and children. This has led to the increase in provision of NAAT upfront for diagnosis of TB from 5.3% of all presumptive TB in 2016 to around 16.3% in 2018 and a peak of 19.2% in 2020. For the period 2018-2022, this proportion has stagnated between 15% and 20%. Culture and drug susceptibility testing laboratories located at Chennai and Madurai."

[25] Tuberculosis case finding in the public sector in Tamil Nadu – Trends and experiences from 2015 to 2022

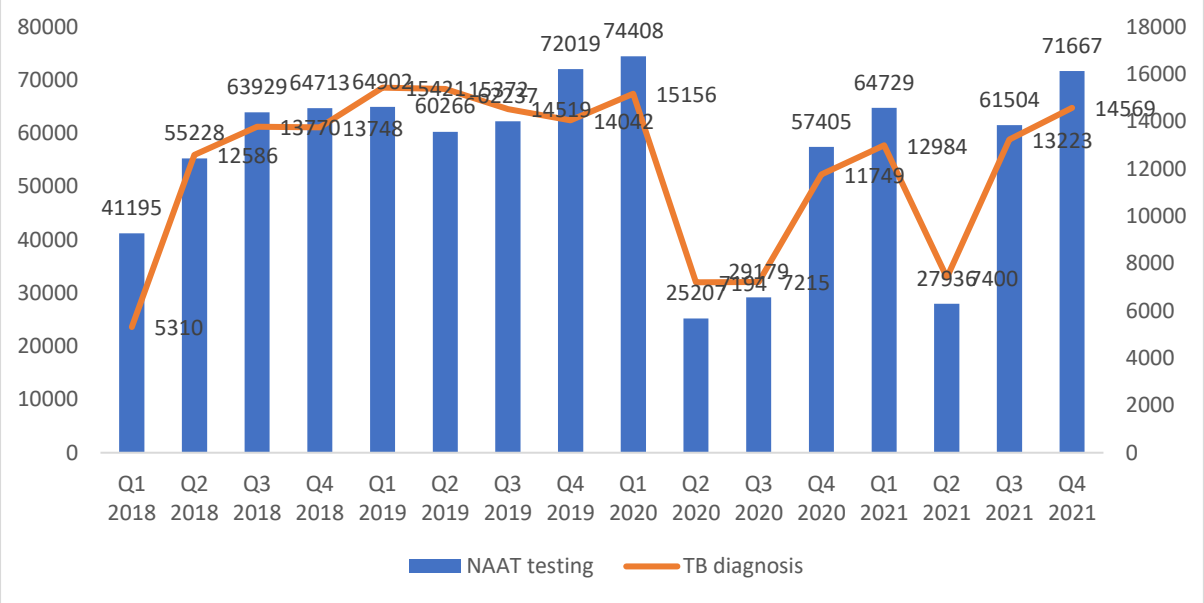
Figure 14: Quarterly presumptive TB investigated by sputum microscopy and diagnosed TB cases in the public sector (2018 – 2021)



The study observed the decrease in the number of sputum microscopy testing, also reduction in the TB diagnosis during COVID W1 and W2.

A paired samples t-test showed that across districts, sputum microscopy testing decreased from 2019 to 2020 ($t = -5.28$, $p < .001$, $d = 30$). However, sputum microscopy testing increased from 2020 to 2021 ($t = 7.38$, $p < .001$, $d = 30$). Similarly, a paired samples t-test showed that across districts, TB diagnosis under sputum microscopy decreased from 2019 to 2020 ($t = -7.33$, $p < .001$, $d = 30$) and the TB diagnosis increased from 2020 to 2021 ($t = 4.45$, $p < .001$, $d = 30$).

Figure 15: Quarterly presumptive TB investigated by NAAT test and diagnosed TB cases (2018 – 2021)



The study observed the decrease in the number of NAAT testing, also reduction in the TB diagnosis during COVID W1 and W2.

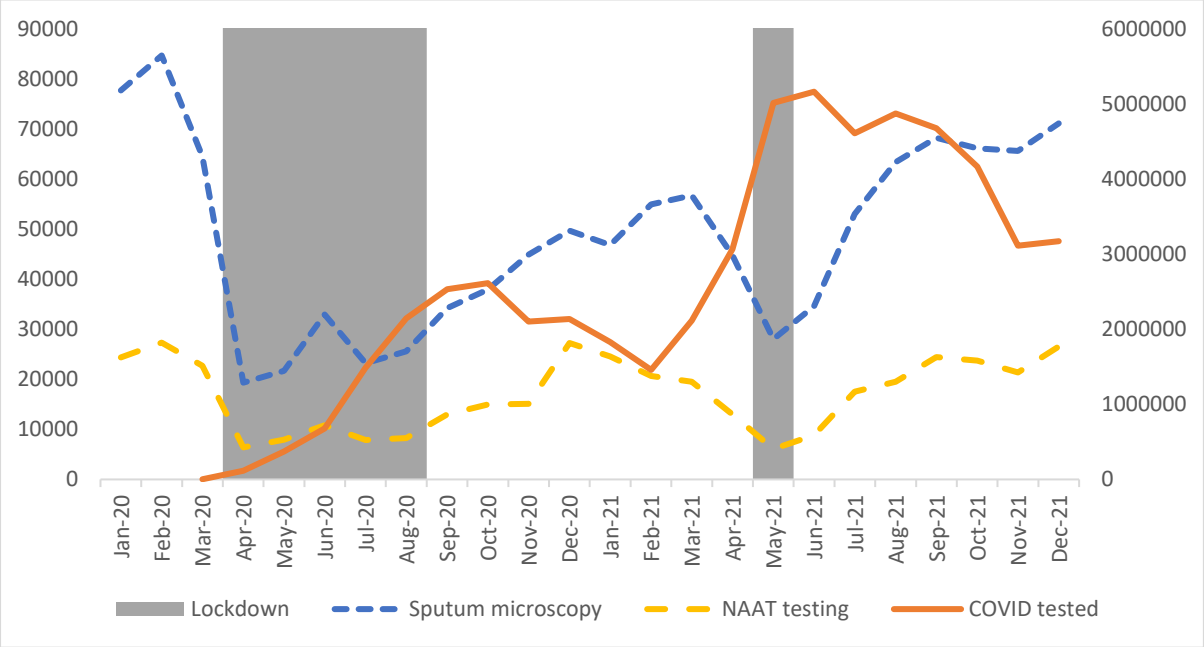
In the third quarter of 2020, NTEP added 147 additional truenat machines in various districts to enhance TB testing. Table 14 presents the CBNAAT and Truenat testing for 2020 and 2021. Key informants from the program suggests that in 2021, some CBNAAT machines were being repaired and also there were shortage of CBNAAT cartridges. As a result, the new truenat machines compensated the gap in testing samples in the districts.

Table 14: CBNAAT and Truenat testing in years 2020 and 2021

Months	CBNAAT testing	Truenat testing	Overall NAAT testing
Jan-20	24379		24379
Feb-20	27318		27318
Mar-20	22711		22711
Apr-20	6391		6391
May-20	7966		7966
Jun-20	10850		10850
Jul-20	7882		7882
Aug-20	8286		8286
Sep-20	12481	530	13011
Oct-20	13489	1503	14992
Nov-20	13487	1645	15132
Dec-20	23950	3331	27281
Jan-21	21308	3242	24550
Feb-21	14169	6465	20634
Mar-21	7235	12310	19545
Apr-21	3219	9771	12990
May-21	1098	4989	6087
Jun-21	1363	7496	8859
Jul-21	1033	16500	17533
Aug-21	438	19091	19529
Sep-21	1266	23176	24442
Oct-21	3963	19788	23751
Nov-21	4608	16748	21356
Dec-21	6486	20074	26560

A paired samples t-test showed that across districts, NAAT testing decreased from 2019 to 2020 ($t = -3.24$, $p < .05$, $d = 30$). However, NAAT testing increased from 2020 to 2021 ($t = 4.27$, $p < .05$, $d = 30$). Similarly, a paired samples t-test showed that across districts, TB diagnosis under NAAT test decreased from 2019 to 2020 ($t = -3.86$, $p < .001$, $d = 30$) and the TB diagnosis increased from 2020 to 2021 ($t = 3.77$, $p < .05$, $d = 30$).

Figure 16: Presumptive TB - Sputum microscopy testing, NAAT testing and COVID testing in Tamil Nadu from January 2020 to December 2021



The testing for presumptive TB using either microscopy or NAAT showed a decline during the lockdowns and gradually increased after the lockdowns were lifted. Similarly, COVID testing reached its peak during W1 and W2, but declined following the waves. Annexure 10 presents the district wise COVID and Presumptive TB testing by sputum microscopy and NAAT. Numbers of NAAT and sputum microscopy were positively correlated over time (Kendal's Tau = 0.74, $p < 0.0001$).

Table 15: Confirmatory diagnostic tests for reported TB cases in years 2018 - 2021

Basis of Diagnosis	**2018**		**2019**		**2020**		**2021**	
Microbiological diagnosis								
CBNAAT	15936	17%	23942	22%	17067	24%	20287	21%
Truenat (MTB)	1	0%	18	0%	496	1%	10920	12%
Truenat (MTB-RIF)	1	0%	8	0%	71	0%	521	1%
Sputum microscopy	40188	42%	40725	37%	25342	36%	29812	32%
Culture	983	1%	328	0%	95	0%	111	0%
DST	32	0%	23	0%	22	0%	16	0%
F Line LPA	794	1%	957	1%	1348	2%	1264	1%
S Line LPA	12	0%	50	0%	49	0%	32	0%
Gene sequencing	0	0%	0	0%	0	0%	2	0%
Clinical diagnosis								
Chest X-ray	12070	13%	22864	21%	12086	17%	11991	13%
Cytopathology	0	0%	0	0%	0	0%	59	0%
Histopathology	0	0%	0	0%	0	0%	161	0%
IGRA	0	0%	0	0%	0	0%	5	0%
TST	0	0%	0	0%	0	0%	16	0%

Others	24968	26%	20693	19%	14538	20%	19330	20%
Total	**94983**	**100%**	**109582**	**100%**	**70547**	**100%**	**83086**	**100%**

Table 16: Basis of TB diagnosis for reported TB cases in years 2018 - 2021

Basis of TB diagnosis	**2018**		**2019**		**2020**		**2021**	
Microbiologically confirmed	57945	61%	66025	60%	43923	62%	51524	62%
Clinically confirmed	37038	39%	43557	40%	26624	38%	31562	38%
Total	**94983**	**100%**	**109582**	**100%**	**70547**	**100%**	**83086**	**100%**

Table 17: Basis of TB diagnosis for reported TB cases in public and private health sectors (2018 – 2021)

Basis of TB diagnosis	**2018**		**2019**		**2020**		**2021**	
Microbiologically confirmed								
Public sector	52369	55%	57905	53%	38645	55%	45682	55%
Private sector	5576	6%	8120	7%	5278	7%	5842	7%
Clinically confirmed								
Public sector	23245	24%	24429	22%	15379	22%	18852	23%
Private sector	13793	15%	19128	17%	11245	16%	12710	15%
Total	**94983**	**100%**	**109582**	**100%**	**70547**	**100%**	**83086**	**100%**

A paired samples t-test showed that across districts, microbiological diagnosis decreased from Pre COVID to COVID years ($t = -7.63$, $p < .001$, $d = 30$). However, microbiological diagnosis increased from 2020 to 2021 ($t = 4.53$, $p < .001$, $d = 30$), in public sector alone ($t = 3.87$, $p < .001$, $d = 30$), not in the private sector ($t = 1.25$, $p > .05$, $d = 28$)

A paired samples t-test showed that across districts, clinical diagnosis decreased from Pre COVID to COVID years ($t = -5.33$, $p < .001$, $d = 30$). However, clinical diagnosis increased from 2020 to 2021 ($t = 3.75$, $p < .001$, $d = 30$), both in public sector ($t = 3.87$, $p < .05$, $d = 30$) and in the private sector ($t = 2.41$, $p < .05$, $d = 28$)

Universal drug susceptibility testing (UDST)

Universal DST for TB involves testing of samples from TB positives for susceptibility to the first-line anti-TB drugs, as well as the second-line drugs used to treat multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB). The testing is typically done using either liquid culture-based methods or molecular methods such as the CBNAAT and Truenat. The NTEP program recommends that all diagnosed with TB should have access to UDST before receiving the TB treatment.

Table 18: Universal drug susceptibility testing (UDST) among notified TB patients in Tamil Nadu from 2018 to 2021

UDST done	2018	2019	2020	2021
Yes	38656 (38%)	75434 (68%)	58144 (82%)	63061 (76%)
No	63038 (62%)	35404 (32%)	12403 (18%)	22725 (27%)
Total TB positives notified	101694	110838	70547	83086

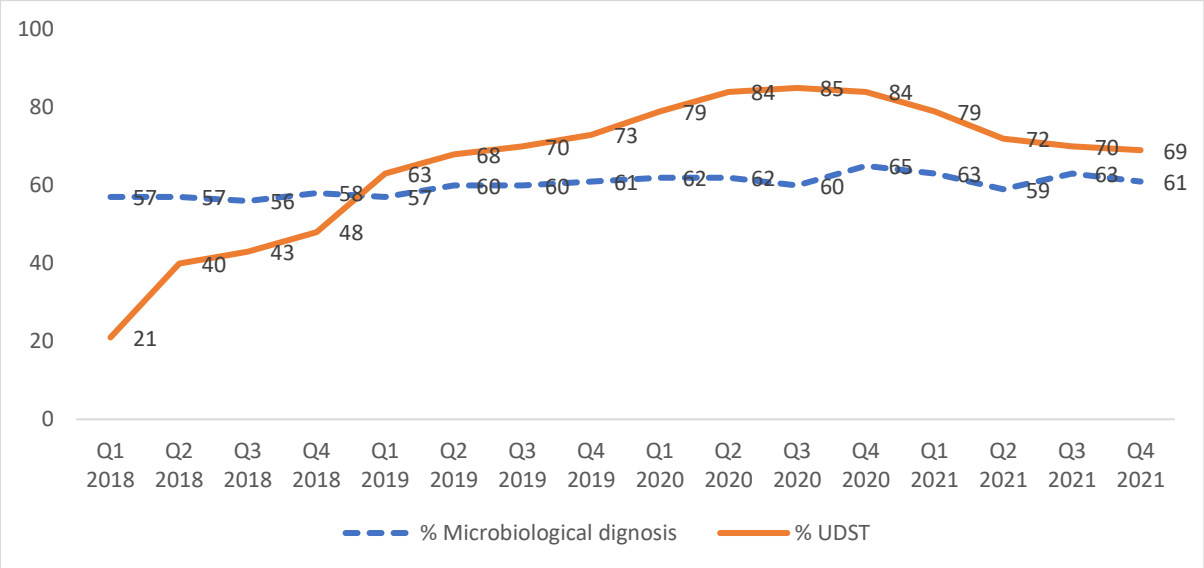
UDST testing has improved over the years, where 82% and 76% of TB patients undergone UDST testing in 2020 and 2021 years respectively

Table 19: Universal drug susceptibility testing (UDST) in public and private sector patients from 2018 to 2021

UDST done	2018	2019	2020	2021
Public	36108 (93%)	67696 (90%)	48735 (84%)	51179 (85%)
Private	2548 (7%)	7738 (10%)	9409 (16%)	9182 (15%)
Total UDST done	38656	75434	58144	60361

There is a decrease in proportion of UDST in public sector in 2020 and 2021 compared to previous years. However the decline is not significant across the districts ($t = -1.24$, $p > .05$, $d = 30$). The proportion increased by 6% in the private sector, but there is a significant increase for the patients from private sector ($t = 4.38$, $p < .05$, $d = 30$)

Figure 17: Percentage UDST tested and microbiologically confirmed diagnosis of TB patients from 2018 to 2021



The line graph indicates that the UDST uptake by the patients increased over the time and reached maximum 85% in Q3 2020 and thereafter decreased in year 2021.

There was an increase of clinical diagnosis-based TB reporting in private sector during the COVID years. Key informants reported that this was due to the minimal or non-availability of NAAT testing in the private sector or most of the private clinicians avoided microbiological confirmation of TB due to the fear of samples collection for NAAT testing. The alternative, Chest X Ray, and CT scan dependent TB diagnosis, has increased during COVID time.

Qualitative key findings around TB testing in the public sector during the COVID pandemic are given below.

There was an additional burden on the NTEP lab staff as some of them were deputed for COVID, resulting in a shortage of lab technicians for TB work, and others with additional COVID responsibilities. The fear of infection was more among health workers who were involved in sputum collection and the laboratory technicians involved in analysing the sputum samples.

Illustrative responses by the health care providers are given below,
"A separate clinic called fever clinic was opened at GH because of which our TB cases dropped. Then we started monitoring our newly diagnosed TB patients through telephone for adverse effects, joint pain, COVID vaccination and if they had any other complaints, they were asked to come back to check RT-PCR" (NTEP).

"Due to increased number of COVID cases in the second wave, all the departments were converted as COVID departments. The second wave was more critical. That time we had less concentration on other cases. We did not have enough space. So, we then referred TB patients to other hospitals like Walajabad and nearby PHCs. There they arranged staff to care for them. Beyond this we don't know what happened to them (HCP 6, tertiary facility).

"…Adding to this, 4 of our 7 LTs were deputed for the COVID work, which led to more difficulties in running the program. Already we had a shortage of LTs in our district and moreover they are at high risk to get infected with COVID since they were handling the sputum which can be highly infectious. They were encouraged to wear a complete PPE kit while testing the sputum and also asked them to wear a double mask" (Program Manager 1).

"We fixed time for each case. Otherwise, all the cases will get infected. COVID cases were tested from 2 o'clock to 5 o' clock. So, sputum tests, chest X-ray and scan could only be done by fixing the time." (HCP 6)

"Some of the CBNAAT machines in the district had to be used for COVID testing purpose. Although that was the case initially, when the COVID wave was severe, many sputum samples had to be discarded because of a smaller number of cartridges in the CBNAAT machines in the latter part. As there was only one CBNAAT machine with 4 cartridges available at a time, only about 20 samples could be tested in a day but they were receiving 40 or more samples per day. This backlog per day would build up. Each sample could be kept for a maximum of 3 days after which it had to be discarded" (NTEP)

The patients also expressed some challenges faced due to the pandemic with respect to lockdown restrictions and delays in TB diagnosis.

"…Since it was COVID time, going to the doctor was difficult. First, I went to a big private Hospital where they tested and were unable to find out. Then I went to a TB hospital, they did

a sputum and blood test, and they said it seems to be TB, but they were not sure. But due to the weight loss and to reduce pain they asked me to take TB tablets. I was referred to GH" (Pt.TB).

“Then I went to another doctor. He asked me to first get a Corona report- only after that we will check. So I got COVID test done and got the report as negative the next day. I took the report to the doctor and he started treatment…He asked me to go to the Government Hospital. I came to the hospital, got the slip and came straight to the TB centre and treatment was started here” (Pt TB).

“HIV and CT scan result will come on the same day. Sputum and blood results take about two to three days. For getting the complete report, it took almost a month. It was delayed due to overcrowding” (Pt TB 4).

Experiences about private sector:

“Most of the private labs and the private hospitals were closed during the lockdown times. Only a few labs who had ICMR portal number were open and they also performed only COVID tests. Even the private physicians who treat TB closed their clinics.” (Program Manager 2)

“Yes, there was a challenge, because most of the places (private labs) were not doing sputum tests... they were just collecting the specimens for COVID... Sputum is contagious because of COVID and not because of tuberculosis. That’s why we had a problem.... all big private labs are here but nobody was doing sputum… concentrated only on COVID testing (HCP 16)

Private HCPs also agreed that sputum tests were not being done because of the potential fear of contagion. The fear of contracting COVID was very high even among health workers.

L. Active Case Finding for TB in Tamil Nadu

Active Case Finding (ACF) refers to the systematic screening of high-risk groups for TB, with the aim of detecting and treating cases of TB that might otherwise go undetected. Systematic active case finding among vulnerable populations and in the community was started in 2017 in the state. Over the study period, more than lakh presumptive TB have been identified and five thousand cases were diagnosed as TB. In July 2020, a targeted case finding campaign was launched with a focus on contacts of TB patients, PLHIV, line-listed NCD patients (especially uncontrolled diabetics and chronic kidney disease patients) and line-listed ILI/SARI patients who have been prescribed home/institutional quarantine. This targeted case finding campaign aided the recovery of TB case finding post the first COVID-19 lockdown.

Table 20: ACF in the state from 2018 to 2021 (Source: Annual TB reports)

Year	Mapped vulnerable population	Population screened among mapped	Presumptive TB cases tested out of screened	TB cases diagnosed among tested
2018	3566777	2972314	357667	1528
2019	7436669	2680756	40703	2542
2020	1148451	281122	14744	395
2021	2588207	1397431	55852	1887

The table presents the total number of individuals screened for symptoms of TB, the total number of individuals identified as presumptive TB, and the total number of individuals diagnosed with TB. Higher the screening numbers, higher the presumptive TB identified and high yield of TB diagnosis.

The data from the STC shows, 16 NTEP districts in 2018, 30 NTEP districts in 2019 and 31 NTEP districts in 2020 and 2021 has conducted ACF in the state.

A paired samples t test showed that across 31 NTEP districts, there is no significance in the numbers of target population, (t is -0.35, $p > 0.05$, df=30) and numbers screened, (t is 0.43, $p > 0.05$, df=30). However, there is a significant increase in evaluation by sputum microscopy (t is 2.32, $p < 0.05$, df=30) and diagnosed TB (t is 2.05, $p < 0.05$, df=30) cases from Pre-COVID to COVID years. The data table presented as **Annexure 11**

Similarly a comparison made among the Wave (W1, W2) periods and Non-wave periods in years 2020 and 2021. **Wave (W1, W2) period –** In 2020 (May to October) and in 2021 (March to July) and **Non-wave period** – In 2020 (March, April, November and December) and in 2021 (January to December). A total of 22 months, 11 months each in wave and non-wave periods.

All the variables show a significant increase from the Wave (W1, W2) to non-wave period, numbers of target population, (t is 6.22, $p < 0.05$, df=30), numbers screened, (t is 5.94, $p < 0.05$, df=30), evaluation by sputum microscopy (t is 5.99, $p < 0.05$, df=30) and diagnosed TB (t is 5.07, $p < 0.05$, df=30) cases. The data table presented as **Annexure 11b**

	Wave (W1,W2) period					**Non Wave period**			
Months	Target population	Screened	Examined Sputum	Patients Diagnosed	Months	Target population	Screened	Examined Sputum	Patients Diagnosed
11 months	230681	79955 (35%)	4632 (6%)	243 (5%)	11 months	3718593	1400790 (38%)	62805 (4%)	3045 (5%)

However the data suggests the yield of TB diagnosis is at 5% during Wave (W1, W2) and Non-wave periods.

Qualitative key findings for Active Case Finding (ACF),

The program stakeholders expressed the importance of ACF for the TB detection,

Whether notification of TB had reduced during the pandemic she said, “We really don’t know whether TB notification has gone down or the spread of TB has reduced. To find out, we need to do active case finding in industries, schools, and places where there are high-risk vulnerable populations. If there are more TB cases in a particular village, then we will screen that entire village for TB. This is our usual operating method.” (HCP 1, DTO).

The above provider went on to describe the difficulties in carrying out contact tracing during the first wave but this improved during the second wave. In her own words, “It was very easy to follow-up the patients who were on treatment. But we were not able to do contact tracing of the newly diagnosed TB patients because of COVID. In the first wave, we didn't notify any new TB patients, but the condition improved during the second wave. This is because we started doing Active Case Finding and contact tracing among the family members of the newly diagnosed TB patients”, (HCP 1 DTO).

"From March 2020 till they relaxed the complete lockdown phase we were not able to do any TB program related activities like active case finding (ACF). But we made sure that the existing TB patients received the drugs on time. Once the complete lockdown was lifted, the program started functioning properly and the patients were able to visit the centre for TB diagnosis and treatment. Activities like ACF, new case identification, OPD referrals were all started as usual", (HCP 2, JDHS).

Setting up camps in various areas as a means to collecting the sputum of patients was another useful strategy that was carried out, ("We carried out active case finding activities like setting up a camp for TB detection, visited lot of villages and collected numerous sputum samples for testing TB, it was more like a door-to-door survey for TB", (HCP 2-JDHS)

M. TB treatment

Table 21: TB Treatment initiation status

Status of treatment initiation	2018	2019	2020	2021
Total TB diagnosis	101694	110838	70547	83086
Treatment initiated	99711 (98%)	108515 (98%)	68473 (97%)	80395 (96.5%)
Treatment not initiated	1983 (2%)	2323 (2%)	2074 (3%)	2691 (3.2%)

The study observed that the proportion of treatment not initiated after TB diagnosis was 2% before COVID and 3% during COVID years (2020-2021). However there is no statistical significance across districts ($t = 0.77$, $p > 0.05$, $d=30$)

- The data among those not initiated on TB treatment indicates that men are more likely than women to not start treatment for TB, with men accounting for three-quarters of such cases while women account for the remaining one-quarter
- The proportion of patients diagnosed and not initiated on treatment is highest in the age group of 45 – 60 years (Average 33.15%) and lowest in 0 – 14 years (Average 2.4%)
- All DR-TB patients were put on treatment in all four years. Increasing percent of patient diagnosed and not initiated on treatment observed in DS TB over the years, 1.8% in 2018, 2.1% in 2019, 3.1% in 2020 and 3.6% in 2021.
- Nearly all the patients diagnosed were initiated on treatment in private sector

Table 22: Site of TB disease among TB diagnosed patients

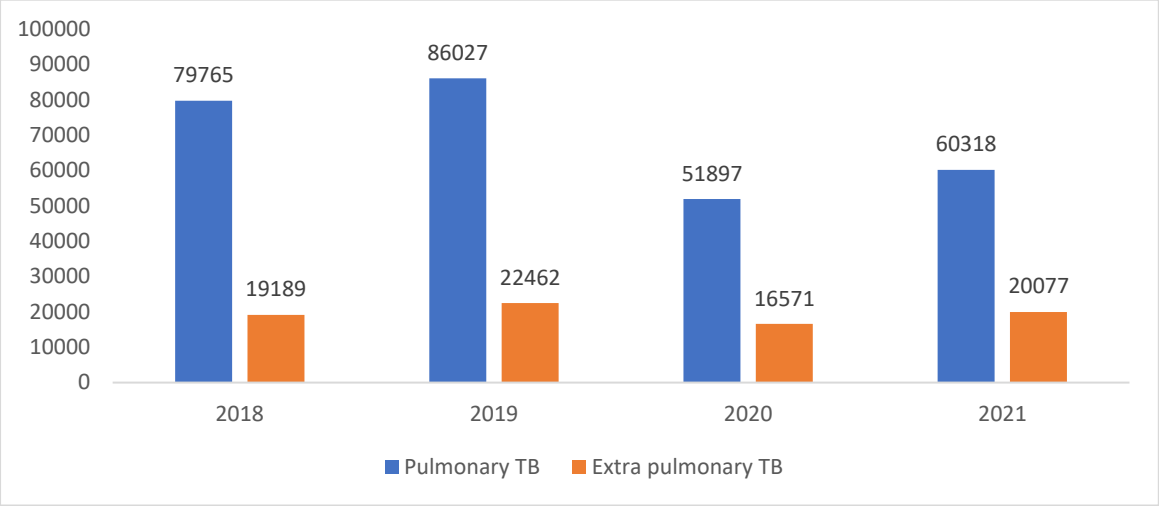
Site of TB disease	**2018**		**2019**		**2020**		**2021**	
Pulmonary TB	79765	80%	86027	79%	51897	75%	60318	75%
Extra Pulmonary TB	19189	20%	22462	21%	16571	25%	20077	25%
Total	**98954**	**100%**	**108489**	**100%**	**68468**	**100%**	**80395**	**100%**

A paired samples t-test showed that across districts, pulmonary TB decreased from Pre COVID to COVID years ($t = -7.58$, $p < .001$, $d = 30$). However, pulmonary TB increased from 2020

to 2021 (t = 5.96, p < .001, d = 30), in public sector alone (t = 4.74, p < .05, d = 30), not in the private sector (t = 0.95, p > .05, d = 38)

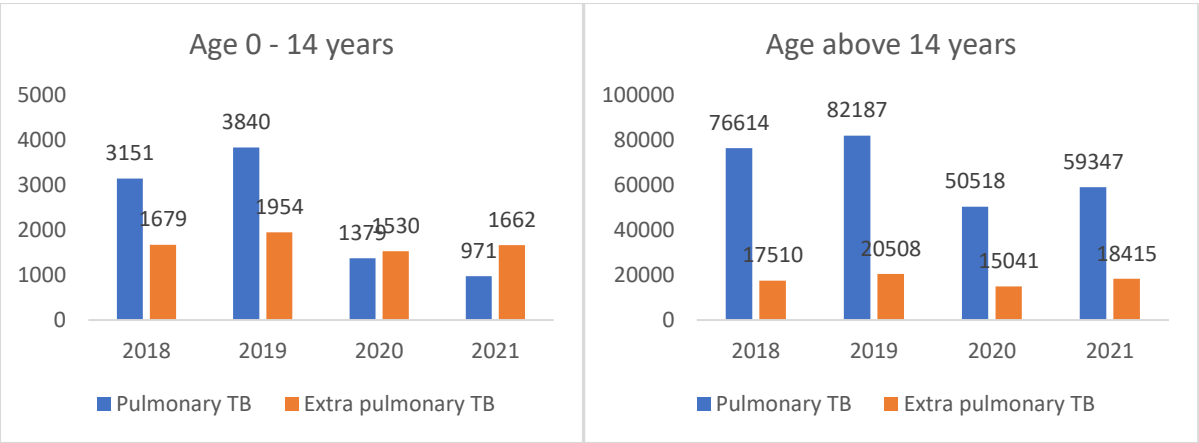
A paired samples t-test showed that across districts, extra pulmonary TB decreased from Pre COVID to COVID years (t = - 3.14, p < .05, d = 30). However, extra pulmonary TB increased from 2020 to 2021 (t = 3.17, p < .001, d = 30), both in public sector (t = 2.75, p < .05, d = 30), and private sector (t = 3.03, p < .05, d = 38)

Figure 18: Site of TB disease among TB diagnosed patients



The study observed there is a decline of both pulmonary and extra pulmonary TB during the pandemic years of 2020 and 2021. Pulmonary TB declined by 33% in COVID compared to Pre-COVID years, while extrapulmonary TB declined by 12% between the two periods. However, this variation doesn't show any statistical significance (p > 0.05).

Figure 19 : Pulmonary and extra-pulmonary TB among age groups 0 – 14 and > 14 years during 2018 to 2021



The data suggests that there is a variation in the age group of 0 – 14 years compared to those aged above 14 years.

- In 0 -14 years age group, pulmonary TB declined by 66% and extrapulmonary TB declined by 12% in COVID years compared to Pre-COVID years.
- In 0 – 14 years, the decrease in pulmonary TB shows a significance ($t = -4.22$, $p < 0.05$, $df = 30$), whereas Extra pulmonary TB doesn't show a significant decline ($t = -1.64$, $p > 0.05$, $df=30$) across districts. Also noted, Extra-pulmonary TB cases were reported higher than the pulmonary TB cases, both in years 2020 and 2021.
- In age above 14 years, pulmonary TB declined by 31% and extrapulmonary TB declined by 12% between the two periods. Similarly, the decrease in pulmonary TB shows a significant decline ($p < 0.05$) in age group above 14 years.

Qualitative key findings:

Health care providers reported that, during COVID, those diagnosed with TB were put on treatment without any delay. Telephonic monitoring and delivering drugs to the patients were the steps taken by the program staff to ensure that the patients on treatment did not suffer from side-effects or had difficulties in getting the medicines. The patients could also immediately communicate to the doctor or the program staff in case of any side-effects.

"After diagnosing a patient with TB, treatment was initiated at the patient's home upon verification, during the pandemic we saw the patient during house visits and provided drugs. We also made telephone calls through our DTC landline to monitor the patient. The police allowed us access into the community when we showed our NTEP ID card, so we were allowed to do the work" (HCP 14).

"During COVID, patients diagnosed with TB were initiated on treatment on the next day itself without any delay…For private patients, their doctor will share the details with PPM Sir. He will follow up with them based on the line list. If the patient belongs to my area, I will follow-up with them over the telephone" (NTEP).

"STS, TB-HV and Pharmacist (NTEP staff) visited the TB patients and gave them the drugs. Sometimes they found it difficult to locate the patient's house and the phone number reported by the TB patient will not be reachable. In those circumstances, they have requested us to take them to their houses and we also helped them. The TB-HV of our PHC visited most of the patient's house, even if it was 12 or 1 noon, she asked others who had vehicles to help her since there was no public transport during that time for drug delivery. NTEP staff even gave their phone numbers to the patients and asked them to call if they needed any help. Patients were also very receptive and they accepted all the advices given by the NTEP staff" (HCP 10)

When asked about the type of TB patients with co-morbidities, these were some of the responses received from the healthcare providers.

"…so all the TB patients, sugar and hypertension patients were affected and more COPD patients affected as well", (HCP 18).

"Even during the COVID times, pregnant women care or follow-up was never compromised. VHNs frequently contact pregnant women and if they have any TB symptoms like cough or fever, they will directly contact me" (Program Manager 1).

Adherence/Drug Compliance:

During COVID, to monitor drug delivery, the program staff were required to call and confirm receipt of drugs by patients and the same was updated online. The other practice was to monitor drug compliance telephonically. There was also good coordination between health facilities at all levels and between districts that aided drug delivery to patients. TB drugs were stocked at all the local PHCs and delivery to TB patients in their area was arranged through an outreach worker. Reaching out to patients in other states and arranging for delivery of ATT drugs was done in a few cases. However, some of the program staff were sceptical of their adherence and believed that many of private patients may have defaulted.

During COVID times, we don't want to trouble the patients by asking them to come here or visit the near-by PHC to get TB drugs. Instead, we instructed our STS to deliver the drugs directly to their houses. The STS made some micro plans to make sure that he delivers the TB drugs to all patients in his area on time" (Program Manager 1).

"Private patients will not take the medicine continuously, there is a gap of 10 to 15 days... patients will tell I went to the private doctor but the doctor was not available. In the following week they will say I don't have money.... see the gap of 15 days. Due to this delay, he may default from the treatment. Every two months patient needs to take x-ray, but they don't have the money to take x-ray so do not consult the doctor for follow up... 50% patients not able to pay the fees, patients could not go continuously" (NTEP)

Most of the patients did not have any difficulties in getting their TB medication as it was delivered to them at their homes. Those who could come to the hospital, did so. Almost all the patients completed their treatment as per their treatment plan during COVID. Only one patient from among those interviewed, reported missing his medicines for about a month due to lack of transportation because of the stringent lockdown.

"I did not come for one month, as there was a strict lockdown and 144 was imposed. The next month when I came, they scolded me for missing one month. I told them that the police were blocking. They asked me why I didn't call them. The mistake I made was that I forgot to call them; I was scared because the police seized vehicles too. They called me from here and asked me to come and I gave them the reason that there was a police problem. They still asked me to come, but I didn't. They told me that they would talk to the police if they stopped me on the way, but I was careless and didn't come. No one came home to give the medicines. They communicated only through the phone…" (Pt TB).

N. TB outcomes

Table 23 : Outcomes of notified TB patients in years 2018 – 2021 (Source: Nikshay TB notification register)

Treatment outcome	**2018**		**2019**		**2020**		**2021**	
Treatment Success	86,419	85%	92795	84%	56852	80.5%	68646	82%
Died	4531	4.4%	6220	5.6%	4862	7%	5638	7%
Lost to follow up	3955	4%	3810	3.5%	1954	3%	2510	3%
Treatment failure	644	0.6%	646	0.6%	391	0.5%	483	1%
Treatment regimen changed	1395	1.4%	2341	2%	2193	3%	1743	2%
Not evaluated	3247	3%	3540	3%	2162	3%	1767	2%
Patient refused	422	0.4%	275	0.25%	154	0.2%	153	0.2%
Untraceable Incorrect address	521	0.5%	395	0.36%	321	0.4%	380	0.4%
Untraceable migrated	170	0.2%	156	0.14%	77	0.1%	94	0.1%
Wrongly diagnosed	56	0.06%	163	0.15%	331	0.4%	849	1%
Duplicate record	323	0.3%	437	0.4%	271	0.4%	0	0%
Total	101683	100%	110778	100%	69568	100%	82414	100%

*Few missing data is not included in the analysis

Overall TB outcomes, the study observed the treatment success rate of 85% in 2018 reduced to 80.5% in 2020 and the death rate increased by 2.6% (4.4% - 7%). Treatment regimen changed increased by 2% (1% - 3%). Loss to follow up decreased by 1% (4% - 3%)

A paired samples t-test showed that across districts, treatment success ($t = -6.98$, $p < 0.05$, $d = 30$), loss to follow up ($t = -4.67$, $p < 0.05$, $d = 30$) and treatment failure ($t = -3.82$, $p < 0.05$, $d = 30$) decreased from Pre COVID to COVID years. Whereas death ($t = -0.70$, $p > 0.05$, $d = 30$) and treatment regimen changed ($t = -0.96$, $p > 0.05$, $d = 30$) do not show any significance increase from Pre COVID to COVID years.

Table 24: Outcomes of TB patients initiated on treatment in years 2018 – 2021

Treatment outcome	**2018**		**2019**		**2020**		**2021**	
Treatment Success	86,419	87%	92795	85%	56,852	83%	68646	86%
Died	4311	4%	5554	5%	4245	6.2%	5089	6%
Lost to follow up	3955	4%	3810	3.5%	1954	3%	2510	3%
Treatment failure	644	1%	646	0.6%	391	0.6%	483	1%
Treatment regimen changed	1395	1%	2341	2%	2193	3%	1743	2%
Not evaluated	2976	3%	3309	3%	1859	3%	964	1%
Total	99700	100%	108455	100%	67494	100%	79628	100%

Among the patients initiated on TB treatment, the study observed the treatment success rate of 87% in 2018 reduced to 83% in 2020 and the death rate increased by 2% (4% - 6%). Treatment regimen changed increased by 2% (1% - 3%). Loss to follow up decreased by 1% (4% - 3%)

Table 25: Deaths of TB diagnosed patients among treatment initiated and not initiated
(Source: Nikshay TB Notification register)

Year	Treatment status	Died		Odds Ratio (OR)	95% CI of OR	p value
		Yes	No			
2018	Not on treatment	220 (11.1%)	1763 (88.9%)	2.76	2.39 – 3.19	<0.001
	On treatment	4311 (4.3%)	95400 (95.7%)			
2019	Not on treatment	666 (28.7%)	1657 (71.3%)	7.45	6.78 – 8.19	<0.001
	On treatment	5554 (5.1%)	102961 (94.9%)			
2020	Not on treatment	617 (29.7%)	1457 (70.3%)	6.41	5.80 – 7.08	<0.001
	On treatment	4245 (6.2%)	64228 (93.8%)			
2021	Not on treatment	549 (19%)	2293 (81%)	3.54	3.21 – 3.90	<0.001
	On treatment	5089 (6%)	75155 (94%)			

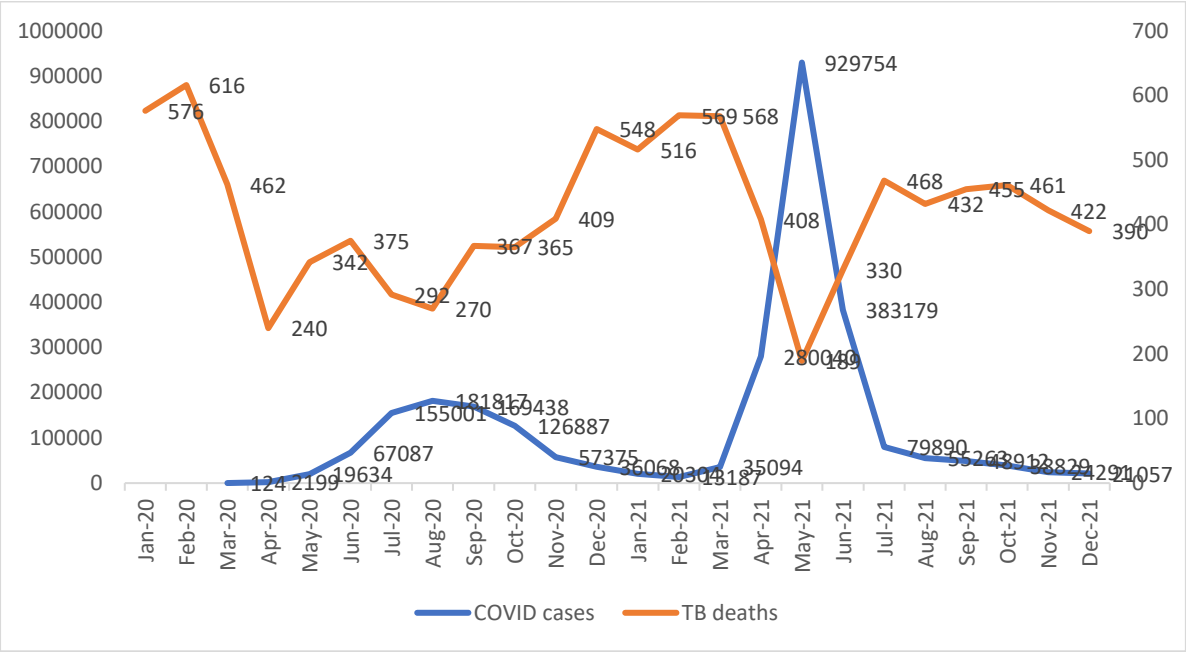
Patients who were not initiated on TB treatment had higher odds of dying compared to patients who initiated on treatment.

COVID case notification and TB deaths reported

Months with higher COVID notification also had lower TB deaths reported ($r^2 = 0.34$, $p < 0.05$). This may be because of challenges in reporting TB deaths when the health system was trying to cope with the surge in COVID cases: however this needs to be investigated further.

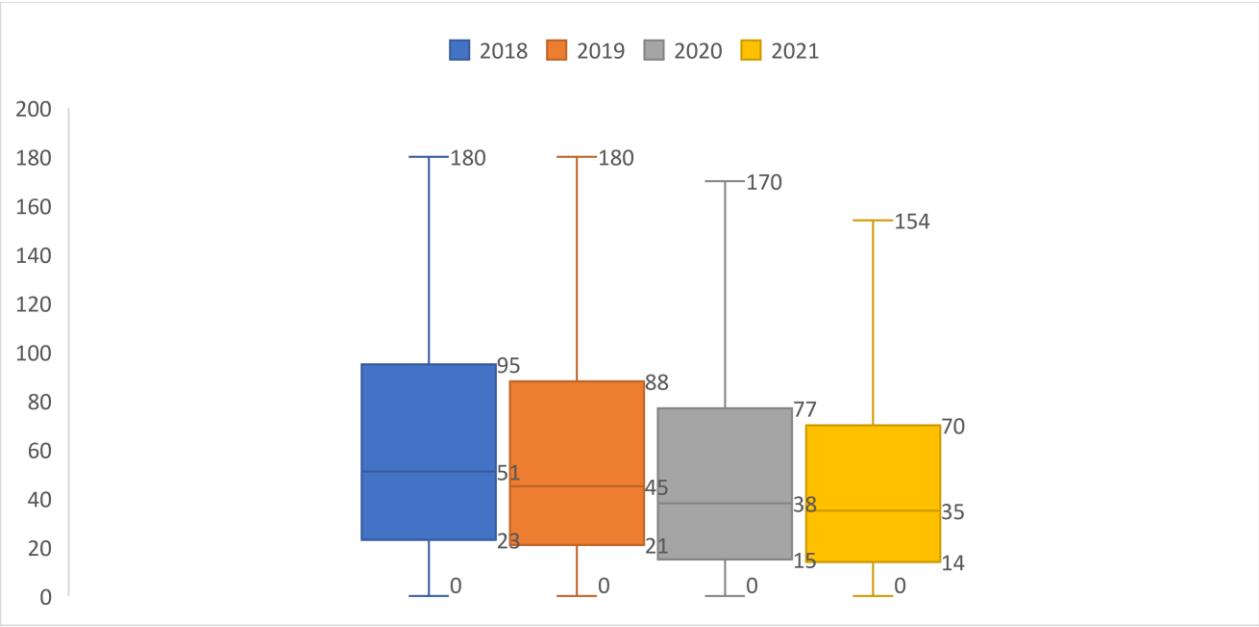
From March 2020 till December 2021, TB deaths reported at an average of 361 per month during Waves (W1, W2) period and average of 446 per month during Non-wave period. This suggests that more TB deaths recorded during the recovery phase/ un lockdown periods although deaths might have happened during the lock down or wave periods. The data suggests that the percentage of TB deaths to TB cases reported was 6.7% during Wave and 6.4% during Non-wave periods. The data suggests high proportion of deaths observed in the elderly age groups > 60 years. TB data shows the increase in deaths as the age of the patients increase.

Figure 20: COVID cases and TB deaths in state Tamil Nadu, Mar 2020 – Dec 2021



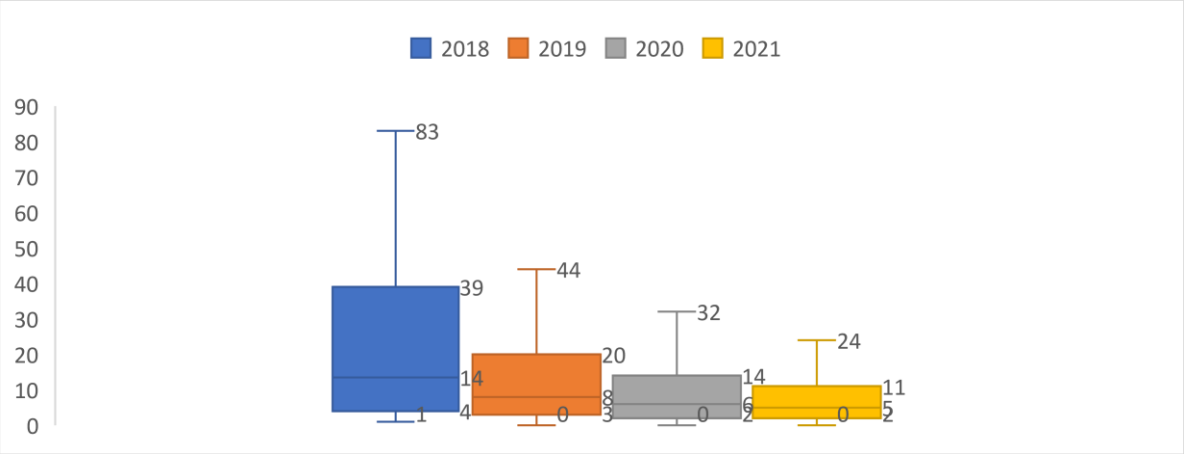
The rank correlation between the reported COVID cases and deaths is statistically significant at p of 0.05 (Kendall's Tau = -0.402).

Figure 21: **Time to death from date of TB diagnosis (In days) among treatment-initiated cases**



For the patients who initiated on treatment, the box plot indicates that the median days taken for patient death from the time of diagnosis is reduced over the period of time. Median of 51 days reduced to median of 38 and 35 days during COVID years, 2020 and 2021 respectively.

Figure 22: Time to death from date of diagnosis (In days) among not on treatment cases



For the patients who were not on treatment, the box plot indicates that the median days taken for patient death from the time of diagnosis is reduced over the period of time. Median of 14 days reduced to median of 6 and 5 days during COVID years, 2020 and 2021 respectively. Hence, the TB diagnosed patients who were not on treatment die early.

O. Contact tracing

Table 26: Contact tracing in years 2018 – 2021

Contact tracing done	2018	2019	2020	2021
Yes	30208 (30%)	77701 (70%)	62459 (89%)	75501 (91%)
No	71486 (70%)	33137 (30%)	8088 (11%)	7585 (9%)
Total	101694	110838	70547	83086

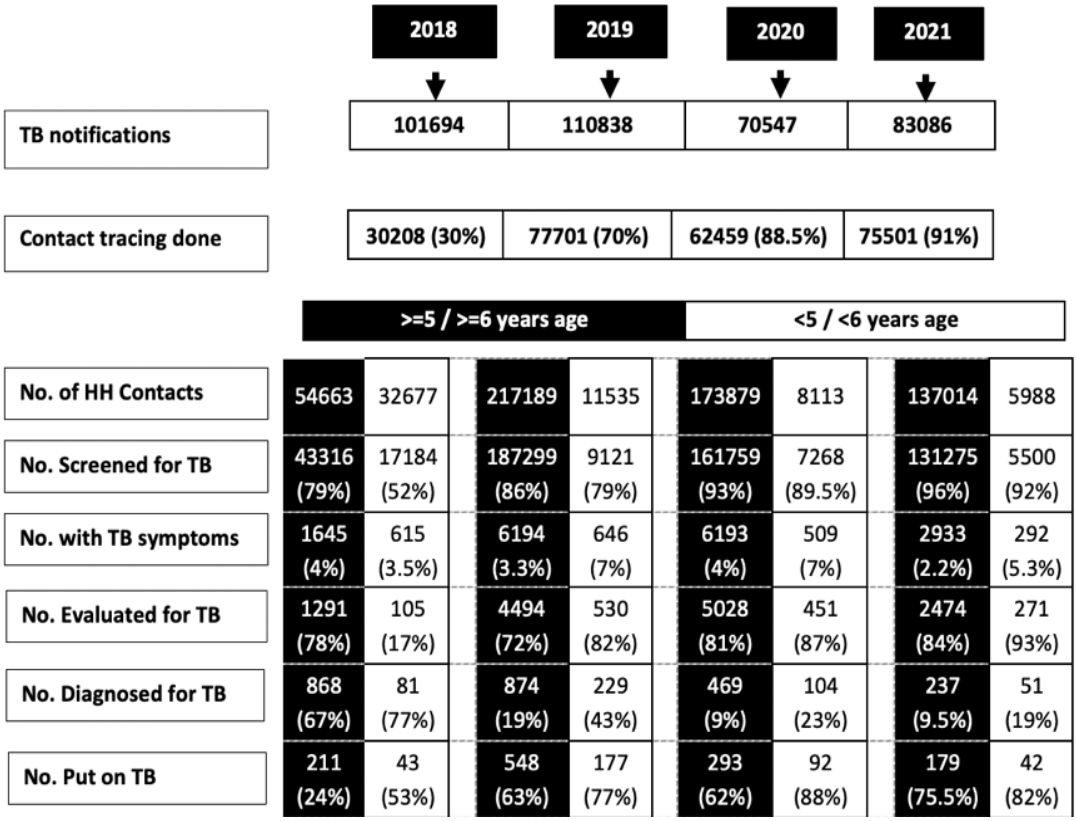
The study observed that the contact tracing has improved over the time, from 30% in 2018 to 91 in 2021

Table 27: Contact tracing for the private and public sector treated TB patients (2018 – 2021)

Contact tracing done	2018	2019	2020	2021
Public	28050 (93%)	69461 (89%)	50717 (81%)	60922 (81%)
Private	2158 (7%)	8240 (11%)	11742 (19%)	14579 (19%)
Total	30208	77701	62459	75501

The proportion of contact tracing in TB patient's households has increased over time in both public and private sectors treating cases. A paired samples t-test showed that across districts, contact tracing increased from Pre COVID to COVID years ($t = 6.46$, $p < .05$, $d = 30$), both in public sector ($t = 1.90$, $p < .05$, $d = 30$), and private sector ($t = 6.18$, $p < .05$, $d = 30$).

Figure 23: Contact tracing cascade from 2018 – 2021 (Source: Contact tracing register, Nikshay)



A paired samples t test across 31 NTEP districts showed that, although there is a decrease in total TB notifications (t is -7.05, $p < 0.05$, df=30) from Pre-COVID to COVID years, there is an increase in the contact tracing (t is 6.46 $p < 0.05$, df=30). Other cascade indicators, number of household contacts do not show a significant change (t is 0.988, $p > 0.05$, df=30), increase in the number of household contacts screened (t is 4.37, $p < 0.05$, df=30), number with TB symptoms do not show a significant change (t is 0.81, $p > 0.05$, df=30), increase in the numbers evaluated for TB (t is 1.74, $p < 0.05$, df=30) and decrease in the number diagnosed on TB (t is -1.96, $p < 0.05$, df=30) and number put on TB treatment (t is -2.84, $p < 0.05$, df=30). The data table presented in **Annexure 12**

Similarly a comparison made among the Wave (W1, W2) periods and Non-wave periods in years 2020 and 2021. **Wave (W1, W2) period –** In 2020 (May to October) and in 2021 (March to July) and **Non-wave period** – In 2020 (March, April, November and December) and in 2021 (January to December). A total of 22 months, 11 months each in wave and non-wave periods.

Table 28: Contact tracing cascade during Wave and Non-wave periods in COVID years

Wave (W1,W2) period								
Months	Total patients	Contact tracing done	No. HH contacts	No. HHs screened for TB	No. with TB symptoms	No. evaluated with TB	No. diagnosed on TB	No. put on TB
11 months	59026	621	112792	106601 (94.5%)	3884 (3.6%)	3198 (82%)	336 (10.5%)	238 (71%)
Non-Wave period								
11 months	94607	1007	212202	199201 (94%)	6043 (3%)	5026 (83%)	525 (10.4%)	368 (70%)

All the variables show a significant increase from the Wave (W1, W2) to non-wave period, total TB notifications (t is 6.78, $p < 0.05$, df=30), contact tracing done (t is 6.63, $p < 0.05$, df=30), number of household contacts (t is 8.43, $p < 0.05$, df=30), number of household contacts screened (t is 8.23, $p < 0.05$, df=30), number with TB symptoms (t is 3.26, $p < 0.05$, df=30), numbers evaluated for TB (t is 3.13, $p < 0.05$, df=30), numbers diagnosed on TB (t is 3.49, $p < 0.05$, df=30) and number put on TB treatment (t is 3.59, $p < 0.05$, df=30). The data table presented as **Annexure 12b**

Although, the qualitative key findings suggest that there were difficulties in conducting contact tracing during the initial pandemic, W1 period with the stringent lockdown measures. However, this has improved after the W1 with relaxation of lockdowns and with the program staff follow ups.

"It was very easy to follow-up the patients who were on treatment. But we were not able to do contact tracing of the newly diagnosed TB patients because of COVID. In the first wave, we didn't notify any new TB patients, but the condition improved during the second wave. This is because we started doing Active Case Finding and contact tracing among the family members of the newly diagnosed TB patients", (HCP 1).

"During that period, it was difficult to screen and do contact tracing, IPT also but at that time patients were not coming, they were fearful of coming to hospital, even the media instructions were to avoid public contact (HCP 14).

Talking about efforts to carry out contact tracing she spoke of the difficulties faced in going from place-to-place visiting patient homes,

"If we are going to see a patient means their household members will be at their house. We will ask them and give container to them. Someone will collect from them and give to us, otherwise I will collect... if they are at home, will give (container) to their household and will ask them to take that test, will ask them to take early morning sputum. 8 o'clock we will come to job. Will collect sputum within 9 o'clock and give in PHC. It was difficult to do this during the COVID pandemic, many areas were blocked, and STS had to come and take us. We do not have separate vehicle and we found it hard to find patients", (HCP)

Preventive treatment/ Chemoprophylaxis. (Source: Annual TB Reports)

In state, before COVID years, the children (< 6 years) eligible for Isoniazid chemoprophylaxis improved by 63% (from 2018 to 2019) and during COVID, declined by 31% (from 2019 to

2020). In year 2021, the state recorded the children less than 5 years as eligible for Isoniazid chemoprophylaxis were 3688.

Relatively, the eligible children (< 6 years) given Isoniazid chemoprophylaxis improved by 69% (from 2018 to 2019) and declined by 40% in 2020. In year 2021, the state recorded the eligible children (< 5 years) given Isoniazid prophylaxis were 2328 (63%).

Table 29: Children eligible and given preventive prophylaxis

Years	Children eligible for Isoniazid chemoprophylaxis	Eligible children given Isoniazid chemoprophylaxis
2018	4358 (< 6 years)	2728 (63%)
2019	11830 (< 6 years)	8749 (74%)
2020	8162 (< 6 years)	5203 (64%)
2021	3688 (< 5 years)	2328 (63%)

P. TB Co-morbidities

Table 30: TB - HIV

Years	Total TB patients notified	Total TB patients with known HIV status (%)	HIV positive patients among tested (%)	TB-HIV coinfected patients initiated on ART	TB-HIV coinfected patients initiated on CPT
2018	107075	76287 (71%)	4099 (5.4%)	3681 (90%)	4055 (99%)
2019	113513	89585 (79%)	3742 (4%)	3453 (92%)	3728 (99.6%)
2020	72147	67097 (93%)	2436 (3.6%)	2309 (95%)	2366 (97%)
2021	84766	80528 (95%)	2984 (3.7%)	2788 (93%)	2941 (99%)

There is an increase in proportion of TB patients with known HIV status over the period of time. A paired t samples test showed that HIV positive patients among tested across 31 NTEP districts showed a significant decline (t is -3.09, $p < 0.05$, df 30) from Pre COVID (2018, 2019) to COVID (2020, 2021) years.

Table 31: TB - Diabetes

Years	Total TB patients notified	Total TB patients with known DM status (%)	Total TB- DM Comorbid patients (%)	TB-DM Co-morbid patients Linked to NCD Clinic
2018	107075	26308 (25%)	5193 (20%)	2231 (43%)
2019	113513	79696 (70%)	16605 (21%)	9490 (57%)
2020	72147	58427 (81%)	16127 (25%)	10817 (67%)
2021	84766	80541 (95%)	21836 (27%)	17594 (81%)

There is an increase in proportion of TB patients with known DM status over the period of time. A paired t samples test showed that TB-DM patients across 31 NTEP districts showed a significant increase (t is 6.72, $p < 0.001$, df 30) from Pre COVID (2018, 2019) to COVID

(2020, 2021) years. TB-DM co-morbid patients linked to NCD clinics increased over the period of time (43% - 81%).

Table 32: TB – Tobacco

Years	Total TB patients notified	Total TB patients with known Tobacco usage status	Tobacco users among TB patients with known usage status	Tobacco users linked with Tobacco cessation centres
2018	107075	16914 (16%)	4354 (26%)	941 (22%)
2019	113513	72944 (64%)	13963 (19%)	3430 (25%)
2020	72147	59085 (82%)	10947 (19%)	2633 (24%)
2021	84766	72962 (86%)	12409 (17%)	2675 (22%)

There is an increase in proportion of TB patients with known Tobacco usage status over the period of time. A paired t samples test showed that Tobacco users among TB patients across 31 NTEP districts showed a significant increase (t is 3.26, $p < 0.05$, df 30) from Pre COVID (2018, 2019) to COVID (2020, 2021) years.

Table 33: TB – Alcohol

Years	Total TB patients notified	TB patients with known Alcohol usage status	Alcohol users identified amongst screened	Alcohol users linked with de-addiction centres
2018	107075	27396 (25.5%)	6538 (24%)	NA
2019	113513	69846 (61.5%)	14700 (21%)	NA
2020	72147	57503 (80%)	11818 (21%)	2589 (22%)
2021	84766	72598 (85%)	14495 (20%)	3205 (22%)

There is an increase in proportion of TB patients with known Alcohol usage status over the period of time. A paired t samples test showed that Alcohol users among TB patients across 31 NTEP districts showed a significant increase (t is 4.47, $p < 0.05$, df 30) from Pre COVID (2018, 2019) to COVID (2020, 2021) years.

Table 34: TB – COVID

Years	Total TB patients notified	TB notified patients screened for COVID disease	TB-COVID 19 patients detected
2020	72147	21792 (30%)	367 (1.7%)
2021	84766	62856 (74%)	518 (0.8%)

In years 2020 and 2021, 30% and 74% of TB patients were screened for COVID and among them 1.7% and 0.8% patients have detected TB with COVID

Table 35: TB – Pregnancy

Years	Female TB patients of child bearing age (15 – 44 years)	Female TB patients screened for pregnancy	Pregnant TB patients identified
2020	30942	7081 (23%)	84 (1.2%)
2021	35227	21207 (60%)	287 (1.4%)

According to 2021 and 2022 Annual TB reports, 23% and 60% of female TB patients were screened for pregnancy and 1.2% and 1.4% were TB with pregnancy in 2020 and 2021 years respectively.

Q. District level programme staffing status

The effectiveness of any program depends significantly on the staffing status. The below table refers to the district positions (In place/ Sanctioned), abstracted from the Annual TB reports for the years 2018 to 2021.

Table 36: District level program staff in place vs sanctioned (2018 – 2021)

Years	DTO	MO-DTC	MO-TC	PPM Coordinator	STS	STLS	LT - NTEP Contractual	TBHV
2018		16/20 (80%)	217/230 (94%)	34/37 (92%)	421/461 (79%)	123/145 (85%)	272/359 (76%)	330/373 (88%)
2019	31/31 (100%)	14/20 (70%)	461/461 (100%)	31/35 (88.5%)	NA	NA	NA	NA
2020	31/31 (100%)	14/20 (70%)	461/461 (100%)	31/35 (88.5%)	424/461 (92%)	120/145 (83%)	263/359 (73%)	337/373 (90%)
2021	31/31 (100%)	14/22 (64%)	461/461 (100%)	33/38 (87%)	434/462 (94%)	114/146 (78%)	267/491 (54%)	343/375 (91%)

During COVID years, few staff cadres were remained unfilled, such as LT-NTEP contractual (37% in 2020 and 46% in 2021), MO-DTC (30% in 2020 and 36% in 2021), PPM Coordinator (11.5% in 2020 and 13% in 2021), STS (8% in 2020 and 6% in 2021), STLS (17% in 2020 and 22% in 2021) and TBHV (10% in 2020 and 9% in 2021).

IV. Summary of Qualitative findings

A. Summary of Qualitative findings -Health care providers

We consolidate below the key findings from HCPS from the six districts that were included in the study. The findings are presented with respect to the following HCP related themes:

I. Perceptions on detection of TB in the community and TB notification during the COVID pandemic
II. Challenges in carrying out TB testing, diagnosis and treatment during the COVID pandemic
III. Perceptions on nature and usefulness of support provided both by government and private sectors
IV. Perceptions on additional needs and strategies to enhance TB management in future pandemic

I. Perceptions on detection of TB in the community and TB notification during the COVID pandemic

The HCPs across all districts spoke of a significant reduction in TB notifications which was uniformly attributed to the lockdown imposed by the government prohibiting movement, closure of public transport services, fears of contracting COVID infection which kept people indoors, refusal of people to provide their sputum for testing for TB and closure of most OPDs in the government hospitals with the focus being almost entirely on management of the pandemic. To a lesser or greater degree all HCPs reported reduced patient footfalls in their hospitals which contributed to reduced testing. Added to this, ACF activities had come to a virtual halt further affecting testing of samples for TB. On those occasions when home visits were made to deliver TB drugs to patients, requests by the health staff for individuals to provide sputum were met with resistance and sometimes hostility. All of these, contributed to reduced detection of TB and TB notifications.

…. During lockdown, people did not come out. Even if they did come out, there was no transport; there was also a lot of fear about coming to GH. The people who came also were not willing to give their contact details. So, for this reason, we would have to go the village; but even if we go, they won't allow us inside their villages as we are from the hospital. There were a lot of challenges during the time. The public were very scared to come to either PHC or GH, because we put those who have COVID on admissions; most importantly there were many deaths. Because of all this, diagnosis was less and hence a smaller number of cases. (HCP 6, STS Rural- NTEP).

However, in the district of Trichy which was a moderate COVID burden district, the MO-TB contended that there had been no drastic reduction in TB notifications and whoever was suspected to have TB was tested. TB infections were purported to be low as people followed good health behaviours

"There was not much change in TB Notifications during COVID time. Only certain amount of lack was there. Since patients weren't willing to give samples, samples could not be received. ..... They were also afraid of getting COVID. They thought if they come, they will be subjected to COVID test also... maybe patients were wearing mask and all, co-infection decreased. Maybe that could have been a reason for less number of active cases. Everyone was asked to

take adequate, nutritious food. Maybe that time only they were having healthy food and no one's immunity dropped. Maybe they didn't have reactivity to their older things. Maybe that could have been the reason also",(HCP 1, MO-TB)

II. Challenges in carrying out TB testing, diagnosis and treatment during the COVID pandemic

Testing and Diagnosis

The burden posed by the COVID pandemic also affected TB testing and diagnostic services across most districts. A major challenge faced was the fact that laboratory technicians (LTs) including those who worked in the TB departments were all deployed to carry our COVID testing. The LTs too were hesitant to undertake sputum testing on account of the fear of contracting COVID infection. This contributed to delays in testing and diagnosis which in turn delayed treatment services. However, most HCPs across the districts added that the delays in obtaining test results were only by a day or two and treatment was initiated thereafter. They contended that that the uptake of services itself was low so undertaking the TB testing on the few who did come to the hospital with symptoms suggestive of TB was not problematic. All the HCPs reported that the situation improved during the second wave when the use of CT scans to diagnose TB and the practice of bi-directional screening was brought into practice as it helped in the detection of TB. However, an opinion expressed by HCPs in Coimbatore was that delays in getting the COVID test results meant that patients were often discharged and as a result the opportunity to carry out TB test was lost in some cases.

"patient would have got admitted and have given a sample for COVID test. Normally we get the report within three days but by the time we get the report the patient would have been discharged and gone... I think we would have missed many cases due to the delay in getting the COVID report", (HCP 6, HV-NTEP).

Some HCPs from Coimbatore and Trichy asserted that while bi-directional screening led to an increase in TB testing, they did not believe it to be very helpful as not many TB cases were identified following this procedure. The availability of CBNAAT and TRUNAAT for TB diagnosis was another positive strategy that aided TB diagnosis

TB patients and COVID patients both will be there. Both will feel breathless. So, we get confused. Crowd was too much. 9 out of 10 patients were COVID and only one was TB patient. Finding out that 10^{th} person was not possible at that time. We have to do investigation for finding out TB patient. So we have to diagnose all 10 patients. Hence, that delay was there. After diagnosis there was no delay in starting treatment because we had drugs with us in all GHs. delay was there in the diagnosis. (HCP 12, Medical College-MO1)

Treatment

The common feature across all six districts with respect to treatment services was that adequate supply of drugs was available for TB patients and no shortages were experienced.

Patients who were seeking care from the private sector had the option to get their drugs for free from the government sector. Arrangements to deliver one month's supply (in some cases two months) of TB drugs to patients at their homes and regular monitoring of TB patients over the phone by the NTEP staff to check for possible side effects of the drugs and to ensure adherence was reported across all the 6 districts.

If AFB is positive and after getting the reports of RFT and LFT, I will start giving ATT the next day. So, we won't delay the work in our department. ..if patients can't come the next day, we will make a call to come here. Otherwise we will inform the concerned STS to go to the

area and tell the patient about their positive result. We will also tell them to start the ATT next day",(HCP 12, MO-TB NTEP)

The Viluppuram site however, indicated that drug supply to patients was erratic during the W1 but regularised during the W2. The HCPs in the Kancheepuram site said that following the experience gained during the W1, they were able to manage the second wave more effectively

"During the second wave, we were able to manage more efficiently by giving preferences to the TB program. TB testing was done for patients with fever and TB symptoms and treatment was started immediately if found to be positive. Still elective surgeries were on hold and more importance was given to the emergency services",(HCP 12, MS-KP)

Treatment of patients diagnosed as DRTB was reported to be challenging. This entailed admitting the patient to carry out various assessments which they were unable to do as all the wards were taken up for COVID care

Also DRTB services we could not establish that well. Drug resistant tuberculosis means pre-treatment evaluation, we first admit patients and evaluate for treatment and then only we start the treatment. We were not able to do that during COVID time.. these were the major difficulty we faced", (HCP 10 DTO-VP). ,

III. Perceptions on nature and usefulness of support provided both by government and private sectors

Almost all HCPs from the six districts described that during the pandemic adequate supplies of PPE kits to all health care personnel engaged in both COVID and TB related care had been made available. The role of many NGOs and private organizations like Lions Club were appreciated for their supply of safety kits like sanitizers and masks. While some HCPs reported that they had been provided with additional staff to manage the COVID crisis, a few others said that they lacked any additional support. They had to manage the situation with limited staff which proved both exhausting and overwhelming more so during the second phase of the pandemic when both the number and severity of sick patients was very high. There was also some criticism from a few HCPs when they were not consulted about their requirements regarding supply of oxygen concentrators for COVID management, "These oxygen concentrators will give only 1 litre of oxygen per minute but patients will be needing at least 10 litres per minute. So these oxygen concentrators were not much of a use. Many people gave a lot of these concentrators without consulting us and it is stored simply without any use", (HCP 12, MS).

With regard to the COVID patients admitted in the wards, HCPs across all the districts reported that they received nutritional support in the form of food and groceries that was arranged for by local NGOs and charitable organizations. Patients belonging to the poorer socioeconomic backgrounds particularly benefited from such assistance. In terms of assistance for TB patients, most of the HCPs believed that TB patients did not receive such support. The DTO from Coimbatore district said that, "NGOs only wanted to support for COVID" (HCP 11, DTO). Many NTEP staff felt that the Rs 500 given through the Nikshay Poshan Yojana was not sufficient and needed to be increased, **"**Everyday they [persons with TB] have to take 1 egg, have to get protein items like cereals, milk like that. These are expensive",(HCP 16, FGD-VHN). Also, poor patients had no balance in their account, so when the Rs. 500 (under the DBT scheme) was deposited in their accounts, this was immediately claimed by the bank thereby defeating the very purpose for which it was intended.

Good practices adopted during the pandemic

Reaching drugs to TB patients either at their homes or to the nearest collection point was cited as one of the good practices by HCPs across all districts. They also reported no shortfall of TB drugs and appreciated the fact that the government had ensured an adequate supply of these drugs for patients. In addition, TB patients seeking care from private doctors were also provided the option of collecting their drugs from the nearest government hospital. One private practitioner in Trichy however, felt that if these drugs had been made available in his hospital, it would have been easier to provide it to his patients, "Patients don't have to go to GH because of prestige issues, so we can give the TB medicines free of cost to the patients in our hospital itself. But they did not provide AKT4 and accurate 4 (TB drugs) we usually provide here. The same drugs they are giving as fixed dose combination in GH. So, we thought that if they could provide us the same, we can give it to patients free of cost. But government did not give us. Some places they have given like that as far as I enquired", (HCP 18, Private Physician).

Other good practices reported by the HCPs related to the use of CT scans for diagnosing TB patients. Subsequently, bi-directional screening was brought in which helped in detection of new TB cases. Monitoring TB patients over the phone as a means of checking on their health and of ascertaining if they were experiencing any adverse effects was also seen as very helpful given that with the lock down in force to and fro travel was difficult. Online monitoring of TB patients through the e-sanjeevani app reported by a few HCPs in Dharmapuri and geo-tagging of TB patients that had been started post COVID by a few HCPs in Madurai were all seen as good ways to follow up TB patients.

Many HCPs were of the opinion that the pandemic had created awareness about the importance of hygiene practices like hand washing and cough etiquette in the community and hoped that it would continue, "Mask has become universal and it is a big advantage for us. All the patients are wearing it and it is comfortable for us. It is easy for me to ask them to wear mask. Earlier, if I ask them to wear mask, they will argue with me. It is a big advantage for us. Then, the respiratory awareness has increased now. Physicians are aware of it and they are taking care. They are differentiating between TB and non- TB", (HCP 10, MO, DP). Some HCPs felt that health seeking behaviour in the community had improved Lab technicians in a couple of districts also said that hand washing practices among health personnel also improved,"Fully hygienic…Personal PPE was bought…It became a routine…handwashing has become normal…Before this, we may not give importance to this…next is biomedical waste management…we usually follow it properly… but after COVID, it has become 200, 300% strictly followed", (HCP 10, Microbiologist- MAD).. In Madurai, one of the HCPs said that the pandemic resulted in filling up the posts of LTs.

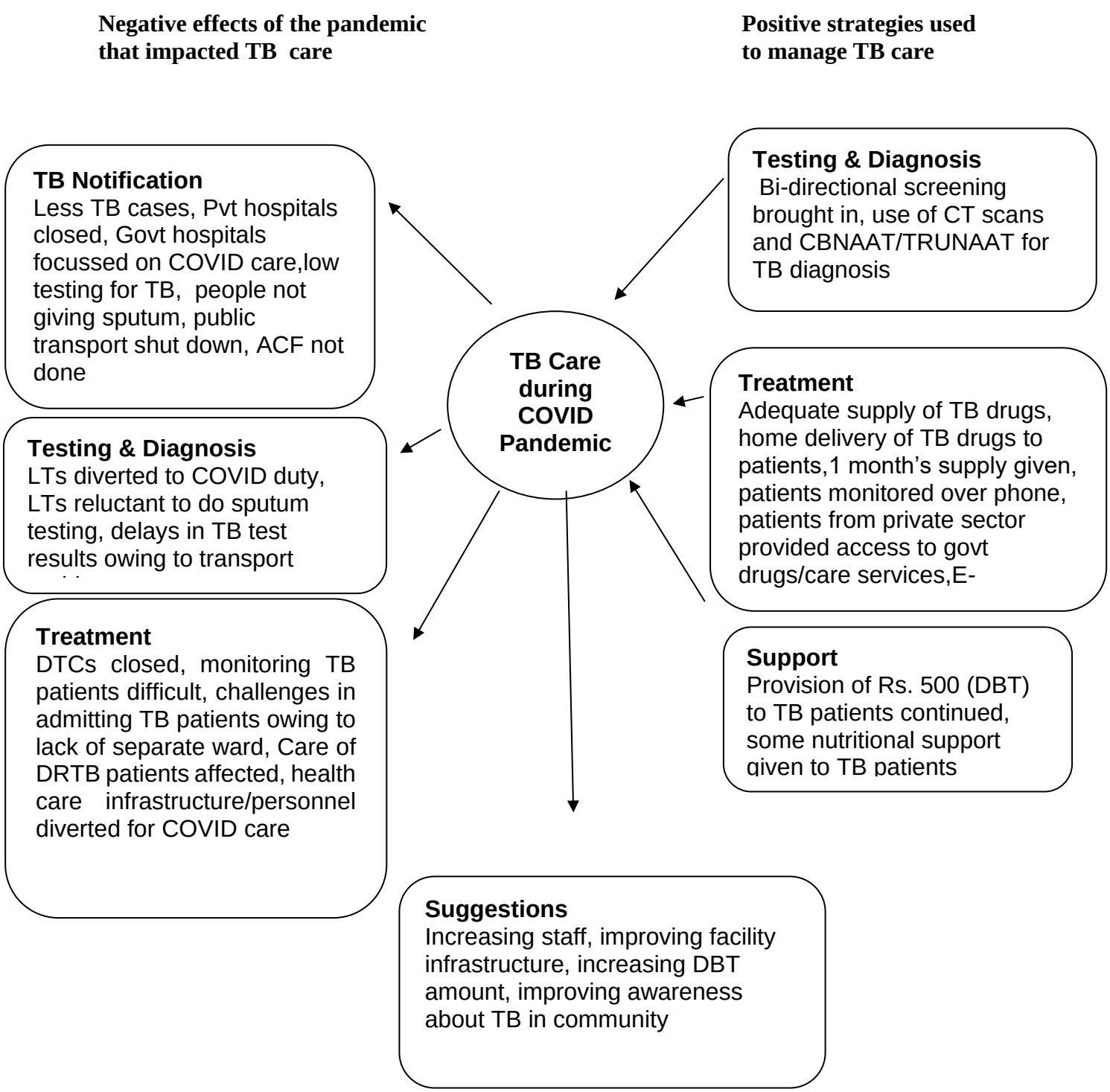
IV. Perceptions on additional needs and strategies to enhance TB management and future pandemics

The HCPs across all districts felt the strong need to improve awareness about TB in the community. One HCP from Madurai GH felt that more focus should be on high risk groups, while another believed that creating powerful advertisements on social media was required, "We do a lot of media, anti-TB week, etc. but I still feel, awareness about TB must improve. Media can help us a lot. There is one ad where the small child sits on the dustbin for public issue. Why are you in the dustbin? For waste segregation. That ad is very catchy. Similarly, some catchy ads should be there and reach should be PAN India. Otherwise, our people will not know about TB", (HCP 6, DTO).

The need for increasing manpower (e.g., increasing the numbers of LTs in government facilities and posting a pulmonologist), improving facilities and infrastructure related to TB diagnosis and management were recommended towards improving TB management in the state, “We can adopt new methods like fluorescent, LED Microscope methods, helps identify more positive cases. We generally have to do UDST, CB NAAT, True Naat etc. If it is available everywhere it reduces delay. It takes more than 7 days generally. If everything is available with each DMC it will be easier”, (HCP 8, STLS-NTEP). One HCP in Coimbatore suggested developing a screening checklist of symptoms similar to NCD for household screening.

Optimising the use of the Makkal Thedi Maruthuvam scheme was suggested wherein their personnel could be used to work actively with the TB staff in ensuring early detection and treatment. A suggestion to incentivise private doctors to report TB cases was also made

Figure 24: HCP perceptions



B. B. Summary of Qualitative findings – Patient groups

The findings below the key findings from patients from the six districts that were included in the study, present according the following two themes:

1. Issues concerning accessing care for TB and quality of care provided during the pandemic
2. Perceptions on nature and usefulness of support provided both by government and private sectors and strategies to enhance TB management

Issues concerning accessing care for TB and quality of care provided during the pandemic

Across all the six districts patients (both TB and COVID), reported satisfaction with the care provided in the government hospitals. The TB patients said that they experienced no shortfalls in drugs which were delivered to them by the TB staff if they were unable to access the hospitals. They were reports by a few patients across most of the districts of some difficulties in accessing the government hospitals during the government imposed lockdowns as public transport had been shut down. Those who had their own means of transport used it to go to the hospital while others had it delivered to them. TB patients from Coimbatore and Trichy described being issued with a medical card that enabled them to travel freely without being stopped by the police. Patients also described phone calls being made by the health staff asking after their health, checking to see if they were experiencing any adverse effects and also to ascertain adherence to their prescribed drug dosage. Most patients reported no delays in starting of treatment

No I did not have any difficulty in seeing the doctor. I would come by bike, bring the TB form and Madam would give the tablet. In every visit, the doctor would write the date and prescribe the tablets and I would also be told when to come back. I used to come back on that date; didn't have any problem; everyone was available, and medicines were also available. I am happy and my treatment has been good" (Pt. TB)

"They give drugs for 2-3 months in bulk, asking us not to shunt back and forth. So we did not feel the tiresome trip to the hospital", (Pt. TB1, TB-HIV).

They came two times during corona. They also checked my mother. They used to send one staff member (sir) to deliver medicines at home"(Pt.TB 2-TRY).

A few pre TB Patients reported that owing to the COVID pandemic they were not able to get a proper diagnosis of their health problem when they visited the government hospital as the focus of the hospitals was entirely on managing the COVID pandemic. Reports of not receiving feedback regarding their test results were also cited by a few pre-TB patients

"Since it was Corona time nobody had any proper answer. They were only giving me medicines and glucose. Then the doctors were also affected with Corona. We could not see the doctors be it here or at the GH",(Pt. Pre-TB1).

"I don't know even now. I came for consultation for cough and cold issue, so I thought only after these tests, they would prescribe the medicines. They didn't tell me whether it's for fever, or sugar or BP, neither did I ask", (Pt. Pre-TB3).

The families of deceased TB patients by and large expressed satisfaction with the care provided to their ill relative in the government hospitals. Although there were a few reports of delays in

obtaining test results, but the families accepted that the doctors and nurses were doing all that was required. Death of the patient was largely attributed to multiple complications that had set in. As was reported by a family member of a deceased TB patient, "maximum treatment was given in the last days and there was nothing more that could be done", (Pt. TB Deceased 8)

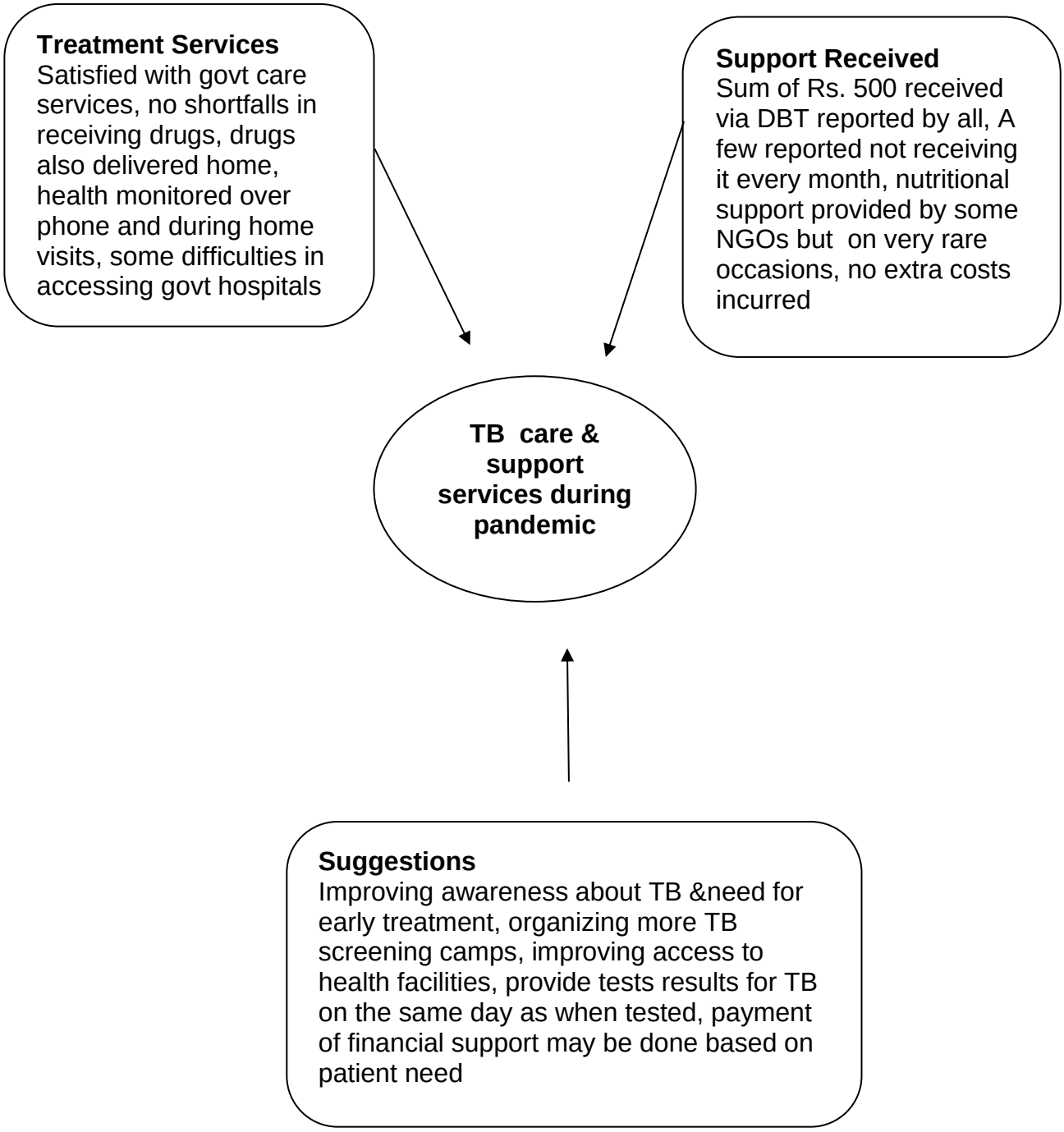
"He didn't take proper food except water. He had a urinary infection and breathing problem…. My husband couldn't walk properly due to weight loss. He was completely bed ridden at that time. So, I bought him tablets for every month and gave him regularly. But, he didn't have food for the past one month. He had only cool drinks, juice and water. He had biscuits without tea and sometimes only tea without biscuits, (TB4)

Perceptions on nature and usefulness of support provided both by government and private sectors and strategies to enhance TB management

Across all sites, all TB patients reported receiving Rs. 500 through DBT although there were a few reports of this not being adequate or not being transferred through all the months of treatment. Nutritional support for TB patients was reported by a few TB patients from Kancheepuram. A few charitable NGOs had organized food and groceries. Bur that apart no patient from any other site reported receiving any food or groceries. Suggestions to improving TB care mostly centred around creating better awareness in the communities about TB, organizing more TB screening camps, conducting regular check-up of TB patients and to improving the amount of monetary assistance to TB patients

They come for malaria, Corona for informing us about the diseases but they have not done the same for TB….should tell people who are unaware that government doctors provide good treatment. Or doctors should spread awareness of such kind of diseases to patients", (Pt Pre-TB2).

Figure 25: Patient perceptions



V. Discussion

This operational research study aimed to assess the effect of COVID-19 pandemic on TB notifications, diagnostic and treatment care services in Tamil Nadu state. The study analysed the state level secondary data on TB reporting and services, and conducted interviews with health care providers, program managers, and patients, including those with presumptive TB, TB and COVID from six study districts.

A. Overall pattern of COVID pandemic and TB notifications

Tamil Nadu reported its first confirmed case of COVID-19 on March 7, 2020[26]. Overall 27,45,430 COVID-19 cases reported from March 2020 to December 2021. Tamil Nadu stands fourth in confirmed COVID cases, after the states, Maharashtra, Kerala and Karnataka as on September 2022[27].

The study results show that the COVID-19 pandemic was associated with the TB case detection and treatment care in Tamil Nadu. Before the pandemic, the state reported 1,04,917 (4.8% of cases in India) and 1,10,845 (4.6% of cases in India) TB cases, with death rates of 4% and 4.9% of notified TB patients in 2018[28] and 2019[29] respectively. According to the National TB prevalence survey conducted in India from 2019 to 2021, Tamil Nadu reported a TB prevalence of 322 (312 in India) cases per lakh population[30]. During COVID years, the state reported 70,304 (3.8% of cases in India) and 82,823 (3.8% of cases in India) TB cases, with death rates of 5.9% and 6% among notified TB patients in 2020[31] and 2021[32] respectively.

Due to the COVID-19 pandemic, the state saw a 36% reduction of TB notifications in 2020 compared to 2019, which was higher than the 33% decrease in TB notifications at the national level. However, there was an 18% increase in TB notifications in 2021 compared to 2020. Even the TB notifications in the country recorded over 21.4 lakh cases in 2021, which is an 18% increase from 2020[33].

The study discusses the implications of the pandemic on TB care and control, as well as the measures taken by the NTEP program and the district health departments to address the challenges posed by the pandemic.

[26] Tamil Nadu reports first COVID-19 case; man tests +ve on return from Oman. https://timesofindia.indiatimes.com/city/chennai/tamil-nadu-reports-first-covid-19-case-man-tests-ve-on-return-from-oman/articleshow/74529856.cms
[27] https://www.statista.com/statistics/1103458/india-novel-coronavirus-covid-19-cases-by-state/
[28] Annual TB report 2020, https://tbcindia.gov.in/showfile.php?lid=3538
[29] Annual TB report 2021, https://tbcindia.gov.in/showfile.php?lid=3587
[30] National TB prevalence survey in India (2019 – 2021). https://tbcindia.gov.in/showfile.php?lid=3659
[31] Annual TB report 2022, https://tbcindia.gov.in/WriteReadData/IndiaTBReport2022/TBAnnaulReport2022.pdf
[32] Annual TB report 2023, https://tbcindia.gov.in/showfile.php?lid=3680
[33] [27] TB cases notified in India in 2021 18% higher than 2020: Health Ministry. https://www.business-standard.com/article/current-affairs/tb-cases-notified-in-india-in-2021-18-higher-than-2020-health-ministry-122102900014_1.html

B. **Implications of pandemic and strategies adopted to minimize disruption of TB services**

The state government has taken several actions to contain the spread and impact of COVID-19. On 15th March 2020, the government prescribed the 'Tamil Nadu COVID-19 regulations, 2020'[34], these regulations detail the responsibilities of hospitals and individuals, and the powers of officials in relation to the diagnosis, treatment, and containment of COVID-19. These include (i) creation of isolation wards in hospitals, (ii) containment measures in an area once positive cases are detected, and (iii) mandatory 14-day home isolation for asymptomatic air travellers from COVID-19 affected countries. The state had also initiated setting up of testing camps and conducting disinfection drives in the border districts. In continuation, the state and districts implemented effective lock down and relaxation policies in years 2020 and 2021 based on the severity of COVID-19 cases being reported.

The study identified several key factors from the qualitative study that contributed to the 36% reduction in TB notifications in the state in 2020 compared to the previous year. These findings include the redirection of TB resources such as lab personnel, program staff and NAAT machines towards managing the COVD-19 crisis[35]. Further lockdowns and travel restrictions made it difficult for patients to access health care facilities [36 37], resulting decrease in healthcare seeking behaviour[38].

Moreover, healthcare providers expressed that COVID-19 and TB patients present with similar symptoms and are often referred primarily for the COVID testing and management. Additionally, there was a sense of apprehension among doctors and lab technicians addressing such respiratory condition. Also few private practitioners, who typically diagnose several TB cases every month did not encounter any new cases during COVID lockdown. Similar findings observed in other Indian cities such as Mumbai and New Delhi, where health practitioners did not come across new cases of TB during the lockdown[39].

According to the study by Karthikeyan et.al, a study titled "Tuberculosis and COVID-19 in India- double trouble!" which suggested that lifting lockdown restrictions could result in a rise in the number of TB patients. Our study indicates that in both years 2020 and 2021, following the lifting of lockdown restrictions has indeed led to an increase in TB notifications in the state. The state was able to effectively manage the disruptions caused by the significant decline in TB notification in 2020 by introducing critical interventions in 2020 and 2021, guided by the

[34] Tamil Nadu COVID-19 Regulations, 2020. https://cms.tn.gov.in/sites/default/files/go/hfw_e_97_2020.pdf
[35] COVID-19 Coronavirus And Tuberculosis: We Need A Damage Control Plan. https://www.forbes.com/sites/madhukarpai/2020/03/17/covid-19-and-tuberculosis-we-need-a-damage-control-plan/?sh=6277587295ca#f72dd45295caExternal%20Link
[36] Private neighbourhood clinics shut; patients struggle to treat minor ailments. https://www.hindustantimes.com/cities/private-neighbourhood-clinics-shut-patients-struggle-to-treat-minor-ailments/story-JIUzCK17OnTZJwEe8XtycI.html
[37] At least 300 hospitals contest department's claim that they are 'temporarily closed'. https://www.thehindu.com/news/national/karnataka/at-least-300-hospitals-contest-departments-claim-that-they-are-temporarily-closed/article32244437.ece
[38] Fear of public healthcare, high medical bills stop people from going for COVID-19 test. https://timesofindia.indiatimes.com/city/ludhiana/fear-of-public-healthcare-high-medical-bills-stop-people-from-going-for-covid-19-test/articleshow/77358011.cms
[39] TB patients badly hit by lockdown — 80% drop in diagnosis, huge struggle for medicines. https://theprint.in/health/tb-patients-badly-hit-by-lockdown-80-drop-in-diagnosis-huge-struggle-for-medicines/411399/

Central TB Division - 'Rapid response plan to mitigate impact of COVID-19 pandemic on TB epidemic and NTEP program activities in India' issued on 4 September 2020 [40]. Consequently, the state saw a rise of 18% in TB notifications from 2020 to 2021. Our study found that the critical interventions include, active case finding campaigns, targeted case finding in NCD clinics, bi-directional screening of COVID and TB cases, Post COVID sequelae patients follow up with NAAT testing, TB screening and testing of all SARI/ILI cases, home sample collection services by the frontline workers and NTEP program staff, case finding strategies in private sector through onsite private health facility visits by the NTEP district program staff and NTEP sending a communication through IMA, IAP, Lab and pharmacist unions. Additionally, NGO services in districts provided support for the sample collection from patient homes, drug delivery to patient homes, and finding new cases through contact tracing activities.

C. Public vs Private sector

According to our study, there has been a rise in reported cases of TB from the public sector during the COVID years. Key informants from the study stated that rise attributed to the installation of additional NAAT (Truenat) machines in districts, the implementation of active case finding campaigns in all Tuberculosis Units (TUs) and increase in testing of presumptive TB / ILI/ SARI/ COVID across the testing centres in public sector; and also the referrals of private sector cases to the public sector for investigation and management, instead of treating in their facilities. Nevertheless, there has been a marked improvement in the reporting of TB cases from private labs in districts where the district TB program has taken proactive measures, such as conducting on-site sensitization, mandating the reporting of TB notifications, offering informant incentives to labs for notifying of TB cases, and sharing of communication through the lab network and unions in the district.

D. Type of TB

Our study indicates a decline in the notification of new, retreatment, and drug-resistant (DR-TB) cases during the COVID years. The reporting of DR-TB cases continued to remain low until the end of 2021, and there is a possibility of an increase in DR-TB cases after 2021, although the study did not explore this further. The low reporting of DR-TB cases, unlike the rise in DS-TB cases following the W2 (Wave 2 period) implies that some individuals with presumptive DR-TB may have died before accessing the treatment care, which can be studied further on this specific group of population.

However, the qualitative findings from the study suggest that the treatment initiation of patients who diagnosed with DR-TB was a challenging, due to a scarcity of pre-treatment evaluation tests, which require patients to be admitted for assessment, that could not be carried out as all wards utilized for the COVID care. Even the WHO factsheet report states that only about one in three people with drug resistant TB accessed treatment in 2020[41].

The study shows that there is a significant decline in pulmonary TB in COVID years compared with extra-pulmonary TB. The decline of pulmonary TB cases starkly seen in children < 14 years, where extra-pulmonary TB cases surpasses pulmonary TB in both 2020 and 2021. A study conducted in Egypt also states that incidence of extra-pulmonary TB as higher than

[40] Rapid response plan to mitigate impact of COVID-19 pandemic on TB epidemic and NTEP program activities in India.
https://tbcindia.gov.in/WriteReadData/l892s/60159559755DODDG_NTEP%20Rapid%20Response_Full.pdf
[41] https://www.who.int/news-room/fact-sheets/detail/tuberculosis

pulmonary TB during COVID years[42]. The key informants from the study stated that the symptoms with extra-pulmonary TB were not limited for investigations unlike the respiratory symptoms which mimics COVID, hence there was no stark difference in reporting observed before and during the COVID years. However, program managers interviewed for the study suggested that more investigation is needed to understand.

E. Treatment outcomes

Pre-treatment loss to follow up (PTLFU), a significant issue in TB care, where patients do not initiate the TB treatment after the TB diagnosis. We found that 2 – 3% patients diagnosed with TB do not begin treatment. Among them, 11% - 30% of patients died during the study period from 2018 to 2021, with higher rates in 2019 and 2020.

A qualitative study[43] titled "Understanding pre-treatment loss to follow-up of tuberculosis patients: an explanatory qualitative study in Chennai, India", conducted by Thomas et.al (2020) states that patients faced challenges navigating the healthcare system, including healthcare worker absenteeism and infrastructure failures, which led to frustration and dropouts. In addition, negative attitudes and behaviours of healthcare workers also contributed to patients distrusting the healthcare system and refusing care. It is likely that these issues were compounded during the COVID-19 pandemic in 2020 and 2021, resulting in more patients being lost to follow-up before treatment initiation.

According to the WHO 2021 Global TB report, TB deaths have increased for the first time over a decade, where more people died of TB, with far few people being diagnosed and treated for TB[44] . Even our study shows the increase of 3% in deaths from 4.4% in 2018 to 7% in 2021. Also our study shows that the patients who were not initiated on TB treatment had higher odds of dying compared to patients who initiated on TB treatment. Moreover the median time taken to death has been lowered from the time of diagnosis to the time of death. Among those who diagnosed and initiated on TB treatment, median of 51 days in 2018 and 45 days in 2019 reduced to median of 38 and 35 days during COVID years, 2020 and 2021 respectively. Among those who diagnosed and not on TB treatment, median of 14 days in 2018 and 8 days in 2019 reduced to median of 6 and 5 days during COVID years, 2020 and 2021 respectively. According to the study, diagnosed TB patients who don't initiate TB treatment will likely die early.

[42] The burden of COVID-19 pandemic on tuberculosis detection: a single-center study. https://ejb.springeropen.com/articles/10.1186/s43168-022-00117-x

[43] Understanding pre-treatment loss to follow-up of tuberculosis patients: an explanatory qualitative study in Chennai, India. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7053785/

[44] Global TB report 2021. https://www.who.int/publications/i/item/9789240037021

VI. Conclusion

The COVID-19 pandemic had a significant impact on TB notifications and delivery of TB services in Tamil Nadu. During the pandemic's first wave, health services were primarily focused on managing COVID-19, leading to a decline in TB case detections. However, the NTEP program's Rapid response plan to mitigate impact of COVID-19 pandemic on TB epidemic has improved the case detections and treatment follow ups in post lockdowns.

Private healthcare providers relied mostly on clinical diagnosis especially radiological investigations. There is a rise in extra-pulmonary TB cases and a decline in pulmonary TB cases, particularly in children under 14 years of age. There was no shortage of public sector drugs reported, private sector patients were directed to public sector for the treatment management due to lockdowns. However private providers stated that they have missed cases for follow up as well as new detections. While patients received public health action services such as contact tracing, door-step drug delivery and receipt of Rs. 500 per month under the DBT for nutrition support, they expressed the scope of strengthening service and timely release of DBT.

TB mortality increased during the COVID-19 years, and the median time taken to death for patients reduced highlighting the need for continued efforts to improve TB services' accessibility and quality during the pandemic and beyond.

VII. Recommendations

The COVID-19 pandemic had a detrimental effect on TB care and services, but it has also presented several opportunities to enhance TB control. Utilizing the knowledge acquired during the COVID-19 pandemic can be crucial in fortifying the efforts towards eliminating TB in the state. The recommendations put forward in the study are relevant for future pandemics that have overlapping respiratory symptoms.

Human resource

The study highlights the importance of continuing the National TB Elimination Program (NTEP) undisturbed as much as possible during pandemic crisis. The program should adopt a balancing act in terms of deputing manpower and diagnostics for crisis management during pandemics, to ensure TB services are not affected. The health system must have adequate lab health personnel to manage both the TB program and integrated health programs. Health system should ensure availability of lab personnel at all testing centres and fill all the vacant positions in the districts. In addition, there is a need to address the fears and anxiety related to the transmission of infection and promote the psychological well-being and occupational efficiency of program staff and lab personnel.

Diagnostics

It is crucial to increase the availability of NAAT (Nucleic Acid Amplification Test) testing machines at the sub-district level, especially the districts that report high number of TB cases. This will enable early diagnosis of cases among the high burden districts. However, it is equally important to ensure that sample collection is carried out with the standard use of personal protective equipment (PPE) and other lab bio-safety measures. The advanced labs and tests that involve lesser exposure to biological specimens can help protect the lab personnel and encourage more individuals to get tested, leading to better control of pandemics in the future.

Case finding

During pandemics, such as the COVID-19 outbreak, it is crucial to screen TB symptomatic's in all special clinics and high-load OPDs in both public and private health sectors. NAAT test should be performed for all presumptive TB patients, Influenza like Illness (ILI), Severely Acute Respiratory Infections (SARI), or chronic respiratory diseases. Bi-directional screening (screening for COVID among the TB patients and screening for TB among all COVID patients) should be implemented at all tiers of healthcare in public and private health sectors. An effective coordination between the clinical and radiology departments for 'CT-scan findings on TB' of all COVID symptomatic's was found to be a good practice adopted by the Coimbatore Medical College and Hospital, this learning could be translated to other districts during pandemic crises.

Active case finding (ACF) in a more focused manner during pandemics targeting vulnerable populations in all tuberculosis units (TUs) in the district. During pandemic, prioritization of care was evident among the pregnancy and new-borns by the frontline health workers, a similar approach can be applied to all mapped vulnerable populations in the district. The focus of targeted screening on those with non-communicable diseases (NCDs), HIV, major co-morbidities, smokers, alcoholics, drug users, children, and pregnant women. Leveraging of services through doorstep health delivery (Makkalai Thedi Maruthuvam -MTM) can ensure that all co-morbidity populations are screened for TB, and early detection and treatment initiation. The use of mobile vans for screening and testing of symptomatic's in hard-to-reach areas and vulnerable pockets can further enhance the effectiveness of TB screening programs during pandemics.

Other existing community engagement and multi-sectoral collaboration activities by the NTEP program should also be leveraged. Effective coordination between the NTEP program staff and community-based frontline health workers for identifying of presumptive TB cases and referrals to health centres for timely diagnosis and treatment initiation. The critical role played by the Women Health Volunteers (WHVs) on the collection of samples from the presumptive TB and TB patients at model blocks, located in Viluppuram district.

Case detection in private health sector

To enhance private provider engagement in districts, it is essential for the NTEP program to actively coordinate with various professional medical associations (PMAs) such as the Indian Medical Association (IMA), Indian Academy of Pediatrics (IAP), Radiology Association, and other chapters including pharmacy and lab unions. This coordination can be leveraged to conduct health screening camps, special clinics and sharing of health communications to all its members.

The NTEP program needs to identify major private sector hospitals, chemists, and labs, and coordinate with them to ensure continuity of TB services. This coordination can include the provision of falcon tubes, tracking of referrals from the private sector, feedback about 'referred patients' to private practitioners, and informant incentives. In addition, conducting sensitization sessions and actively reach out to private labs and health facilities for TB notification. Utilizing the informant incentive strategy for private labs can be helpful, especially when private hospitals and clinics are not functioning during pandemics. Periodic follow-ups by the NTEP program with pharmacies and labs can help track un-notified TB patients. To strengthen the CT-scan based detection of presumptive TB cases and ensure those presumptive TB case samples are tested under NAAT. Through these efforts, private provider engagement can be promoted during pandemic crises.

Transportation

During pandemics, such as the COVID-19 crisis, patients should be allowed unrestricted access to transportation services. Innovative mechanisms, such as "Fast Track" cards, can be given to patients to reach higher referral centres in the district. For example, the Kancheepuram district has adopted this practice, which should be scaled up across the state. In remote and hard-to-reach areas, special screening drives for TB and other health conditions should be planned, and the patient samples from the screening camps are transported to the NAAT centres on the same day. The NTEP program recognized the importance of sample transportation and adapted various good practices for sample transportation to NAAT centres (with in a district) and Intermediate reference laboratories (inter-district), further, to set up a routine monitoring system to track the number of presumptive TB samples being tested with in the district and at the state.

Communication strategies

There is a crucial need for increased awareness about TB through various platforms, including television and social media. Similar practices adopted during the COVID pandemic should be implemented to increase awareness about TB, which is also a major respiratory infectious disease. A communication strategy should differentiate TB and COVID, highlighting the importance of TB evaluation for all chronic respiratory symptoms and long COVID symptoms. Posters should be displayed at all health facilities about COVID and TB and their management. Targeted communication strategies among healthcare providers to positively reinforce for TB diagnosis and keep motivation levels high for identifying presumptive TB and evaluation.

Treatment management and public health action

Differentiated TB care for vulnerable populations, including those with HIV, diabetes, tobacco and alcohol addiction, is crucial in preventing a higher number of deaths during pandemics. In addition, functional isolated TB wards, particularly for MDR-TB patients, at every district hospital/medical college, even during pandemic emergencies. It is essential to track the initiation of treatment for all diagnosed TB patients to prevent pre-treatment loss to follow-ups (PT-LFU), as the study shows that higher deaths occurred among individuals diagnosed with TB but not initiated on anti-tuberculosis treatment (ATT). Another crucial aspect is to ensure public health action during pandemics, all the household contacts are screened for TB, evaluate symptomatic contacts for TB and initiate TB preventive therapy for all eligible contacts. It is recommended that the practice of providing uninterrupted drug supply to patients, including home delivery of drug stocks, which was beneficial during the pandemic, should be continued for all patients, including those residing in hard-to-reach areas or tuberculosis units (TUs) within the district.

Multi-sectoral convergence

A multi-sectoral approach to reach out to vulnerable groups for case detection and treatment follow-up. The NTEP program should leverage pre-existing coordination with all other departments in districts to identify and reach out to vulnerable populations. Advocacy campaigns through TB champions in the community help to improve TB control efforts.

Telemedicine/ tele counselling

The study recommends the ways to improve TB diagnosis and treatment using technology and innovative methods during the pandemic crisis. Online monitoring of TB patients through the e-sanjeevani (National Teleconsultation service), as reported by some healthcare providers in Dharmapuri, and geo-tagging of TB patients, started post-COVID by some healthcare providers in Madurai, were seen as good practices to follow up with TB patients.

Telemedicine is also recommended to improve the new case detection, where focus on follow-up of long COVID symptoms and other chronic respiratory illnesses are investigated for TB. The tele-counselling model that has been demonstrated to be effective for post-COVID patients, involves follow-up phone calls, counselling, and advising patients to visit the hospital for chest X-rays and NAAT investigations. This same approach can be expanded throughout the pandemic period to enhance the detection of TB and increase operational efficiency.

IX. Annexures

Annexure 1: Districts categorization based on the COVID-19 burden

S.no	Districts	Population	COVID population	% COVID affected population
1	Chennai	4646732	567337	12.2%
2	Coimbatore	3458045	251039	7.3%
3	Kancheepuram	3722645	247972	6.7%
4	Erode	2251744	111864	5.0%
5	The Nilgiris	735394	34489	4.7%
6	Tiruppur	2479052	96667	3.9%
7	Viluppuram	2093003	77414	3.7%
8	Theni	1245899	43737	3.5%
9	Kanyakumari	1870374	63402	3.4%
10	Tiruvarur	1264277	42012	3.3%
11	Tiruvallur	3728104	122398	3.3%
12	Tuticorin	1750176	56265	3.2%
13	Thanjavur	2405890	77234	3.2%
14	Namakkal	1726601	53977	3.1%
15	Salem	3482056	100981	2.9%
16	Tiruchirappalli	2722290	78946	2.9%
17	Vellore	4415092	124064	2.8%
18	Nagapattinam	1702082	44428	2.6%
19	Tirunelveli	3072880	78234	2.5%
20	Madurai	3038252	76266	2.5%
21	Cuddalore	2605914	64385	2.5%
22	Virudhunagar	1942288	45981	2.4%
23	Karur	1064493	25144	2.4%
24	Krishnagiri	1883731	43730	2.3%
25	Tiruvannamalai	2464875	54232	2.2%
26	Perambalur	1320117	28911	2.2%
27	Dharmapuri	1506843	29094	1.9%
28	Pudukkottai	1618345	30120	1.9%
29	Dindigul	2159775	33804	1.6%
30	Sivagangai	1339101	20844	1.6%
31	Ramanathapuram	1353445	20459	1.5%
	Tamil Nadu	16,16,450	2745430	3.9%

(Source: COVID data shared by the state health department, Tamil Nadu)

Districts categorized in to,

- > 4% people affected with COVID as high burden districts (5 districts)
- 2.6 - 4% people affected with COVID as moderate burden districts (13 districts)
- ≤ 2.5 % people affected with COVID as less burden districts (13 districts)

Note: In the state, there are total 38 administrative districts. But the study considered 31 NTEP districts, where 5 NTEP zones of Chennai (Central, North, South, East and West) considered as NTEP district and erstwhile districts

Annexure 2: District wise study participants for KII and FGDs

Study participants	KP	CBE	VPM	DMP	TRY	MAD	Total
Stakeholders (3)							
DTO	1	1	1	1	1	1	6
DDHS							
JDHS	1				1	1	3
MS	1	1				1	3
BMO/CMO			2	1	1		4
NTEP staff (5)							
MO-TB	1	1	1	1	1	1	6
STS	1	1		2	1	1	6
TBHV	1	1	1	1	1	1	6
Pharmacist			1				1
LT/ STLS	1	1	2	1	1	1	7
Treatment Organizer	1						1
District Program Coordinator		1					1
PPM Coordinator	1	1		1	1	1	5
Health care – MOs (4)	3	4	4	4	4	4	23
Health care – SN/ GNM (4)	3	5	4	4	4	4	24
Private practitioners (4)							
Private doctors	1	2	2	2	2	3	12
Private pharmacists	1	1	2	2	2	2	10
Patients (9)							
Presumptive TB (3)	3	3	2	3	0	5	16
TB cases (3)	4	8	3	5	14	12	46
COVID cases (3)		1	3	3	2	5	14
FGD (2)							
UHN	1		1	1	1	1	5
VHN	1	1	1	1	1	1	6
HIV-TB Coordinator - Outreach worker (1)		1	1	1			3
TB NGO/ NGO (1)		1	1		1		3
Total (30 + 2 per district)	24 + 2	35 + 1	30+2	32+2	39+2	43+2	203+11

KP – Kancheepuram, CBE – Coimbatore, VP – Villupuram, DMP – Dharmapuri, TRY – Trichy and MAD - Madurai

Note: Total 46 TB cases, 32 males and 14 females. Age groups 10 of < 18 years, 11 of 18 – 30 years, 11 of 31 – 45 years, 9 of 46 – 60 years and 5 > 60 years. Three DR-TB patients, Ten extra-pulmonary TB. 21 from first wave and 25 from second wave. Three TB HIV, six deceased TB and six private sector patients.

Annexure 3: COVID-19 in districts in 2020 and 2021

Districts	Population (Census 2011)	COVID 2020 numbers	COVID 2020 per lakh population	COVID 2021 numbers	COVID 2021 per lakh population
Chennai	46,46,732	225109	4844	342228	7365
Coimbatore	34,58,045	51963	1503	199076	1822
Cuddalore	26,05,914	24523	941	39862	4553
Dharmapuri	15,06,843	6507	432	22587	1056
Dindigul	21,59,775	10998	509	22806	2161
Erode	22,51,744	14073	625	97791	4343
Kancheepuram	3722645	78479	2108	169493	1531
Kanyakumari	18,70,374	16352	874	47050	2468
Karur	10,64,493	5184	487	19960	2495
Krishnagiri	18,83,731	7694	408	36036	1673
Madurai	30,38,252	20921	689	55345	1067
Nagapattinam	17,02,082	7922	465	36506	2373
Namakkal	17,26,601	11155	646	42822	1776
Perambalur	13,20,117	6828	517	22083	2303
Pudukkottai	16,18,345	11308	699	18812	5757
Ramanathapuram	13,53,445	6269	463	14190	1048
Salem	34,82,056	31541	906	69440	1819
Sivagangai	13,39,101	6561	490	14283	1994
Thanjavur	24,05,890	17205	715	60029	1499
The Nilgiris	7,35,394	8029	1092	26460	1530
Theni	12,45,899	16819	1350	26918	2454
Tirunelveli	30,72,880	23670	770	54564	1162
Tiruvallur	37,28,104	43715	1173	78683	2480
Tiruvarur	12,64,277	10984	869	31028	1875
Tiruppur	24,79,052	16820	678	79847	3221
Tiruvannamalai	24,64,875	18928	768	35304	2145
Tiruchirappalli	27,22,290	14358	527	64588	1432
Tuticorin	17,50,176	15964	912	40301	1913
Vellore	44,15,092	43735	991	80329	2516
Viluppuram	20,93,003	25769	1231	51645	2111
Virudhunagar	19,42,288	16247	836	29734	3598
Tamil Nadu	7,24,39,796	815630	1126	1929800	2664

(Source: COVID data shared by the state health department, Tamil Nadu)

Annexure 4: COVID cases and deaths across districts in 2020 and 2021

District	COVID Cases 2020	COVID Deaths 2020	COVID cases 2021	COVID Deaths 2021
Chennai	225109	4045	342228	4627
Coimbatore	51963	647	199076	1858
Cuddalore	24523	280	39862	595
Dharmapuri	6507	61	22587	229
Dindigul	10998	200	22806	452
Erode	14073	142	97791	573
Kancheepuram	78479	1153	169493	2625
Kanyakumari	16352	256	47050	807
Karur	5184	50	19960	312
Krishnagiri	7694	109	36036	245
Madurai	20921	459	55345	746
Nagapattinam	7922	127	36506	538
Namakkal	11155	108	42822	414
Perambalur	6828	69	22083	440
Pudukkottai	11308	155	18812	267
Ramanathapuram	6269	131	14190	219
Salem	31541	455	69440	1267
Sivagangai	6561	125	14283	92
Thanjavur	17205	237	60029	789
The Nilgiris	8029	48	26460	177
Theni	16819	204	26918	317
Tirunelveli	23670	371	54564	565
Tiruvallur	43715	677	78683	1182
Tiruvarur	10984	109	31028	347
Tiruppur	16820	217	79847	805
Tiruvannamalai	18928	280	35304	390
Tiruchirappalli	14358	180	64588	934
Tuticorin	15964	140	40301	264
Vellore	43735	649	80329	1906
Viluppuram	25769	215	51645	354
Virudhunagar	16247	227	29734	318
Tamil Nadu	815630	**12126**	**1929800**	**24654**

(Source: COVID data shared by the state health department, Tamil Nadu)

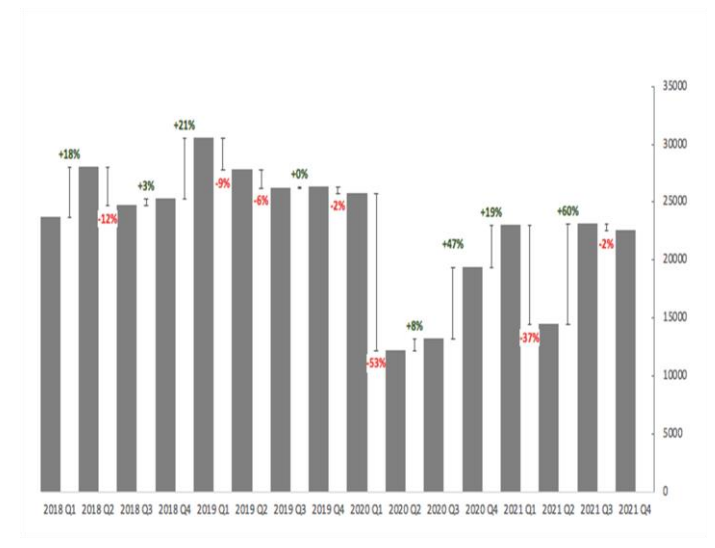
Annexure 5: Rate of COVID cases and deaths across districts (2020 – 2021)

District	Dist. Population	Cases per lakh (2020)	Deaths per lakh (2020)	Cases per lakh (2021)	Deaths per lakh (2021)
Chennai	46,46,732	4844	87	7365	100
Coimbatore	34,58,045	1503	19	5757	54
Cuddalore	26,05,914	941	11	1530	23
Dharmapuri	15,06,843	432	4	1499	15
Dindigul	21,59,775	509	9	1056	21
Erode	22,51,744	625	6	4343	25
Kancheepuram	3722645	2108	31	4553	71
Kanyakumari	18,70,374	874	14	2516	43
Karur	10,64,493	487	5	1875	29
Krishnagiri	18,83,731	408	6	1913	13
Madurai	30,38,252	689	15	1822	25
Nagapattinam	17,02,082	465	7	2145	32
Namakkal	17,26,601	646	6	2480	24
Perambalur	13,20,117	517	5	1673	33
Pudukkottai	16,18,345	699	10	1162	16
Ramanathapuram	13,53,445	463	10	1048	16
Salem	34,82,056	906	13	1994	36
Sivagangai	13,39,101	490	9	1067	7
Thanjavur	24,05,890	715	10	2495	33
The Nilgiris	7,35,394	1092	7	3598	24
Theni	12,45,899	1350	16	2161	25
Tirunelveli	30,72,880	770	12	1776	18
Tiruvallur	37,28,104	1173	18	2111	32
Tiruvarur	12,64,277	869	9	2454	27
Tiruppur	24,79,052	678	9	3221	32
Tiruvannamalai	24,64,875	768	11	1432	16
Tiruchirappalli	27,22,290	527	7	2373	34
Tuticorin	17,50,176	912	8	2303	15
Vellore	44,15,092	991	15	1819	43
Viluppuram	20,93,003	1231	10	2468	17
Virudhunagar	19,42,288	836	12	1531	16
Tamil Nadu	**7,24,39,796**	**1126**	**17**	**2664**	**34**

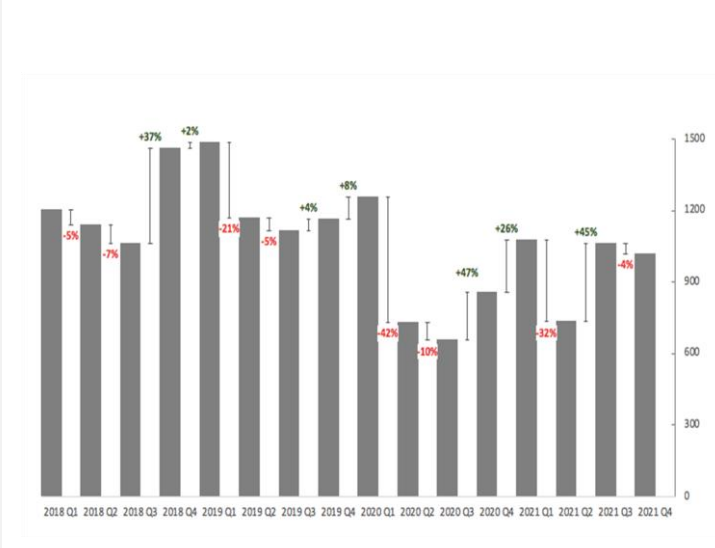
(Source: COVID data shared by the state health department, Tamil Nadu)

Annexure 6: Quarterly percent change of TB notifications in Six study districts during 2018 – 2021

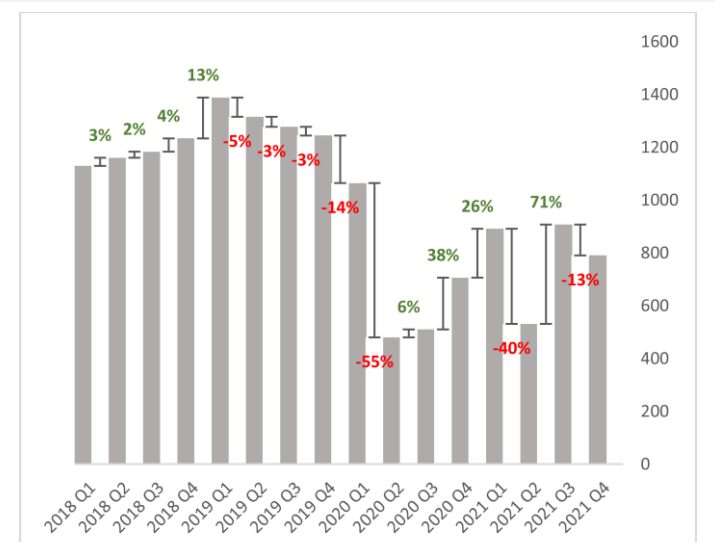
Kancheepuram



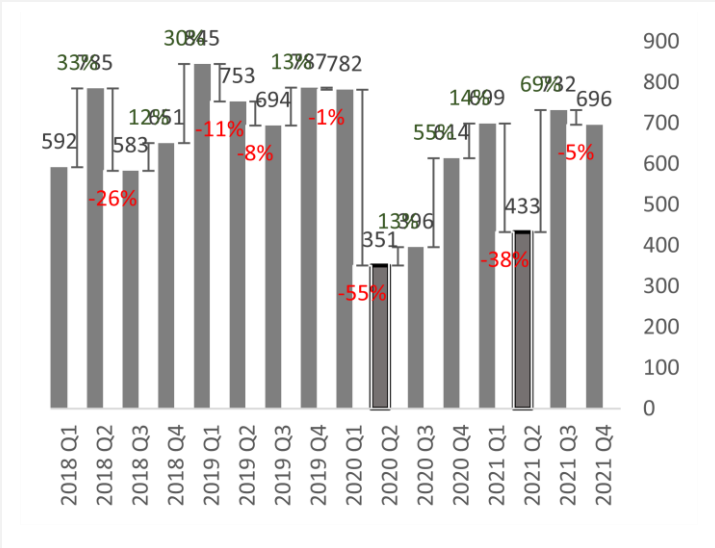
Coimbatore



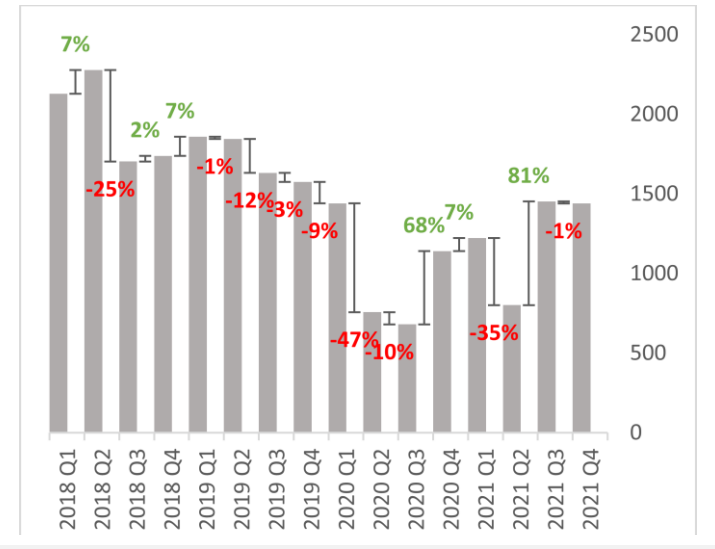
Viluppuram



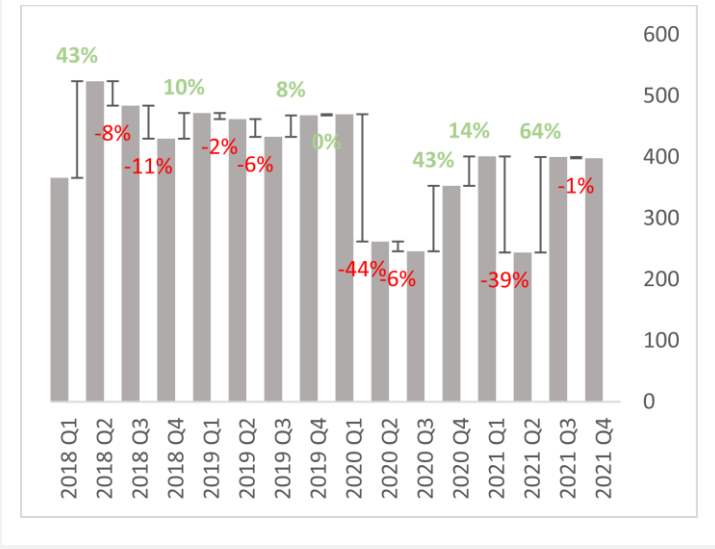
Tiruchirappalli



Dharmapuri



Madurai



Annexure 7: Rate of TB reporting in districts in 2018 – 2021 based on diagnosis facility

Districts	Population (Census 2011)	TB 2018 numbers	TB 2018 per lakh population	TB 2019 numbers	TB 2019 per lakh population	TB 2020 numbers	TB 2020 per lakh population	TB 2021 numbers	TB 2021 per lakh population
Chennai	46,46,732	13,939	300	17,513	377	10,988	236	13,438	289
Coimbatore	34,58,045	4,866	141	4,933	143	3,496	101	3,888	112
Cuddalore	26,05,914	2,961	114	3,144	121	1,993	76	2,439	94
Dharmapuri	15,06,843	1,804	120	1,835	122	1,331	88	1,443	96
Dindigul	21,59,775	3,015	140	3,505	162	2,380	110	2,960	137
Erode	22,51,744	4,081	181	4,533	201	2,389	106	2,812	125
Kancheepuram	3722645	5,887	158	6,722	181	4,498	121	5,648	152
Kanyakumari	18,70,374	1,584	85	1,760	94	1,080	58	1,258	67
Karur	10,64,493	1,069	100	1,221	115	718	67	888	83
Krishnagiri	18,83,731	2,150	114	1,715	91	1,267	67	1,286	68
Madurai	30,38,252	7,849	258	6,911	227	4,019	132	4,917	162
Nagapattinam	17,02,082	1,809	106	1,808	106	1,196	70	1,291	76
Namakkal	17,26,601	2,040	118	1,990	115	1,307	76	1,468	85
Perambalur	13,20,117	1,651	125	1,847	140	1,211	92	1,552	118
Pudukkottai	16,18,345	1,447	89	1,820	112	1,035	64	1,411	87
Ramanathapuram	13,53,445	2,060	152	2,274	168	1,426	105	1,508	111
Salem	34,82,056	4,449	128	5,031	144	2,967	85	3,575	103
Sivagangai	13,39,101	1,758	131	2,241	167	1,470	110	1,538	115
Thanjavur	24,05,890	3,759	156	4,029	167	2,500	104	2,862	119
The Nilgiris	7,35,394	302	41	310	42	189	26	189	26
Theni	12,45,899	1,861	149	2,357	189	1,386	111	1,702	137
Tirunelveli	30,72,880	4,352	142	4,665	152	2,827	92	3,481	113
Tiruvallur	37,28,104	2,473	66	2,097	56	1,297	35	1,669	45
Tiruvarur	12,64,277	1,475	117	1,487	118	1,043	82	1,174	93
Tiruppur	24,79,052	2,297	93	2,478	100	1,760	71	2,064	83
Tiruvannamalai	24,64,875	2,231	91	2,440	99	1,623	66	1,740	71
Tiruchirappalli	27,22,290	4,705	173	5,224	192	2,760	101	3,119	115
Tuticorin	17,50,176	2,665	152	2,817	161	1,802	103	1,981	113
Vellore	44,15,092	4,975	113	5,563	126	4,218	96	4,803	109
Viluppuram	20,93,003	2,611	125	3,079	147	2,143	102	2,560	122
Virudhunagar	19,42,288	3,569	184	3,489	180	2,228	115	2,422	125
Tamil Nadu	7,24,39,796	1,01,694	140	1,10,838	153	70,547	97	83,086	115

(Source: Nikshay TB notification register)

Annexure 7b: Rate of TB reporting in districts in 2018 – 2021 based on current facility

District	Dist. Pop	2018		2019		2020		2021	
		Number	Per Lac	Numbers	Per Lac	Numbers	Per Lac	Numbers	Per Lac
Chennai	4646732	12508	269	14707	317	9630	207	11425	246
Coimbatore	3458045	4707	136	4658	135	3226	93	3588	104
Cuddalore	2605914	3194	123	3408	131	2145	82	2598	100
Dharmapuri	1506843	1673	111	1729	115	1261	84	1323	88
Dindigul	2159775	2973	138	3432	159	2391	111	2973	138
Erode	2251744	3203	142	3582	159	2132	95	2583	115
Kancheepuram	3722645	4054	109	4896	132	3233	87	4223	113
Kanyakumari	1870374	1416	76	1556	83	964	52	1136	61
Karur	1064493	1323	124	1552	146	887	83	1031	97
Krishnagiri	1883731	2365	126	1959	104	1423	76	1450	77
Madurai	3038252	7311	241	6264	206	3371	111	4374	144
Nagapattinam	1702082	1946	114	2015	118	1368	80	1539	90
Namakkal	1726601	2186	127	2333	135	1477	86	1663	96
Perambalur	1320117	1714	130	1937	147	1256	95	1645	125
Pudukottai	1618345	1745	108	2182	135	1261	78	1678	104
Ramanathapuram	1353445	2213	164	2477	183	1602	118	1706	126
Salem	3482056	4467	128	5116	147	3009	86	3512	101
Sivagangai	1339101	1746	130	2150	161	1383	103	1447	108
Thanjavur	2405890	3555	148	3828	159	2302	96	2524	105
The Nilgiris	735394	317	43	324	44	219	30	246	33
Theni	1245899	1797	144	2248	180	1376	110	1673	134
Tirunelveli	3072880	4389	143	4753	155	2929	95	3530	115
Tiruvallur	3728104	3426	92	3492	94	2232	60	2916	78
Tiruvarur	1264277	1493	118	1493	118	1003	79	1170	93
Tiruppur	2479052	3052	123	3309	133	2212	89	2507	101
Tiruvannamalai	2464875	2616	106	3044	123	1994	81	2181	88
Tiruchirappalli	2722290	4521	166	4914	181	2617	96	3002	110
Tuticorin	1750176	2770	158	2952	169	1875	107	2052	117
Vellore	4415092	5230	118	5826	132	4252	96	4860	110
Viluppuram	2093003	3309	158	3841	184	2634	126	3167	151
Virudhunagar	1942288	3823	197	3769	194	2372	122	2611	134
Tamil Nadu	**72439796**	**101042**	**139**	**109746**	**151**	**70036**	**97**	**82333**	**114**

(Source: Nikshay TB notification register)

Annexure 8: Annual percent change of TB notifications by 31 NTEP districts in years 2018 – 2021

Districts	2018	2019	2020	2021	Notification pattern over the years	% change in 2019	% change in 2020	% change in 2021	COVID 2020	COVID 2021
Chennai	13939	17513	10988	13438		26%	-37%	22%	225109	342228
Coimbatore	4866	4933	3496	3888		1%	-29%	11%	51963	199076
Cuddalore	2961	3144	1993	2439		6%	-37%	22%	24523	39862
Dharmapuri	1804	1835	1331	1443		2%	-27%	8%	6507	22587
Dindigul	3015	3505	2380	2960		16%	-32%	24%	10998	22806
Erode	4081	4533	2389	2812		11%	-47%	18%	14073	97791
Kancheepuram	5887	6722	4498	5648		14%	-33%	26%	78479	169493
Kanniyakumari	1584	1760	1080	1258		11%	-39%	16%	16352	47050
Karur	1069	1221	718	888		14%	-41%	24%	5184	19960
Krishnagiri	2150	1715	1267	1286		-20%	-26%	1%	7694	36036
Madurai	7849	6911	4019	4917		-12%	-42%	22%	20921	55345
Nagapattinam	1809	1808	1196	1291		0%	-34%	8%	7922	36506
Namakkal	2040	1990	1307	1468		-2%	-34%	12%	11155	42822
Perambalur	1651	1847	1211	1552		12%	-34%	28%	6828	22083
Pudukkottai	1447	1820	1035	1411		26%	-43%	36%	11308	18812
Ramanathapuram	2060	2274	1426	1508		10%	-37%	6%	6269	14190
Salem	4449	5031	2967	3575		13%	-41%	20%	31541	69440
Sivaganga	1758	2241	1470	1538		27%	-34%	5%	6561	14283
Thanjavur	3759	4029	2500	2862		7%	-38%	14%	17205	60029
The Nilgiris	302	310	189	189		3%	-39%	0%	8029	26460
Theni	1861	2357	1386	1702		27%	-41%	23%	16819	26918
Thiruvallur	2473	2097	1297	1669		-15%	-38%	29%	43715	78683
Thiruvarur	1475	1487	1043	1174		1%	-30%	13%	10984	31028
Thoothukudi	2665	2817	1802	1981		6%	-36%	10%	15964	40301
Tiruchirappalli	4705	5224	2760	3119		11%	-47%	13%	14358	64588
Tirunelveli	4352	4665	2827	3481		7%	-39%	23%	23670	54564
Tiruppur	2297	2478	1760	2064		8%	-29%	17%	16820	79847
Tiruvannamalai	2231	2440	1623	1740		9%	-33%	7%	18928	35304
Vellore	4975	5563	4218	4803		12%	-24%	14%	43735	80329
Viluppuram	2611	3079	2143	2560		18%	-30%	19%	25769	51645
Virudhunagar	3569	3489	2228	2422		-2%	-36%	9%	16247	29734
Tamil Nadu	**101694**	**110838**	**70547**	**83086**		**9%**	**-36%**	**18%**	**815630**	**1929800**

The above table illustrates the state and district-level TB notifications for the study years, 2018-2019 (pre-COVID years) and 2020-2021 (COVID years) from both public and private health sectors. The majority of NTEP districts show an increase in TB notifications between 2018 and 2019, with the exception of five districts - Krishnagiri, Tiruvallur, Madurai, Namakkal, and Virudhunagar. In 2020, TB notifications show a decline by 36% (range of 24 - 47% across districts) compared to 2019 levels; and 18% increase in 2021 (range of 0 - 36% across districts) compared to 2020 in the state. The COVID-19 had an impact on the TB notifications progress made in 2019, and by the end of 2021, neither the state nor the districts TB notifications had increased to the levels of 2019. Notifications of TB cases was 139 per lakh in 2018, 151 per lakh in 2019 which lowered to 97 per lakh in 2020 and 114 per lakh in 2021 in the state

Annexure 9: Quarter wise heat map of TB notifications by 31 NTEP districts in years 2028 – 2021

Districts	2018				2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Chennai	3076	3590	3593	3680	4648	4295	4457	4113	4251	1349	2271	3117	3974	2512	3845	3107
Coimbatore	1204	1140	1063	1459	1485	1169	1116	1163	1256	730	654	856	1075	733	1062	1018
Cuddalore	644	832	727	758	921	795	715	713	613	399	347	634	672	424	662	681
Dharmapuri	366	524	484	430	472	462	433	468	470	262	246	353	401	244	400	398
Dindigul	789	726	692	808	991	850	704	960	822	386	461	711	781	500	800	879
Erode	884	1206	979	1012	1077	1258	1105	1093	942	428	409	610	825	473	717	797
Kancheepuram	1249	1691	1452	1495	1893	1722	1540	1567	1596	685	856	1361	1655	991	1583	1419
Kanniyakumari	403	495	331	355	546	435	404	375	399	178	187	316	350	208	344	356
Karur	249	239	273	308	354	306	255	306	256	121	138	203	229	169	231	259
Krishnagiri	502	601	560	487	492	443	394	386	425	271	272	299	351	236	335	364
Madurai	2129	2278	1703	1739	1859	1845	1632	1575	1441	757	680	1141	1223	801	1453	1440
Nagapattinam	420	542	435	412	494	444	417	453	405	235	258	298	359	248	339	345
Namakkal	581	578	426	455	564	443	435	548	472	250	242	343	385	245	391	447
Perambalur	364	488	458	341	470	469	467	441	462	211	203	335	384	234	441	493
Pudukkottai	365	444	347	291	501	436	457	426	409	178	170	278	400	229	414	368
Ramanathapuram	503	561	553	443	561	564	566	583	551	231	255	389	410	264	418	416
Salem	1000	1432	1103	914	1428	1323	1145	1135	996	614	566	791	958	525	1034	1058
Sivaganga	461	452	404	441	564	611	553	513	523	282	259	406	446	236	421	435
Thanjavur	711	1098	994	956	1062	1028	983	956	960	426	482	632	818	494	769	781
The Nilgiris	65	81	83	73	86	78	72	74	60	41	40	48	57	38	45	49
Theni	469	520	399	473	737	558	532	530	474	251	229	432	446	262	439	555
Thiruvallur	556	816	537	564	607	522	514	454	473	217	234	373	424	273	470	502
Thiruvarur	418	348	341	368	435	419	324	309	356	234	186	267	320	230	305	319
Thoothukudi	484	818	692	671	811	724	679	603	605	343	338	516	519	344	529	589
Tiruchirappalli	1129	1160	1183	1233	1388	1315	1277	1244	1064	480	510	706	891	531	907	790
Tirunelveli	1042	1225	1076	1009	1257	1141	1073	1194	1060	474	486	807	914	576	983	1008
Tiruppur	539	574	541	643	756	600	575	547	600	359	381	420	514	377	577	596
Tiruvannamalai	437	628	622	544	735	584	573	548	594	297	302	430	503	322	457	458
Vellore	1160	1282	1171	1362	1485	1408	1303	1367	1589	750	756	1123	1379	849	1332	1243
Viluppuram	592	785	583	651	845	753	694	787	782	351	396	614	699	433	732	696
Virudhunagar	893	836	880	960	1034	787	812	856	835	425	367	601	688	429	644	661
Tamil Nadu	**23684**	**27990**	**24685**	**25335**	**30558**	**27787**	**26206**	**26287**	**25741**	**12215**	**13181**	**19410**	**23050**	**14430**	**23079**	**22527**

The heat map helps visualize TB notifications by district over time. The years 2018 and 2019, pre COVID-19 years being the reference period and years 2020 and 2021, COVID-19 years.

The heat map shows that during the quarters with a COVID surge and lock downs (Q2, Q3 2020, and Q2 2021), districts experienced a significant decrease (with a greater red hue) in TB notifications, and a steady rise (with a waning red hue) during partial or full unlock downs/ recovery phases following the COVID-19 W1, W2

Annexure 10: Presumptive TB testing by Sputum microscopy, NAAT and COVID testing

	Sp. microscopy (2019)	Sp. microscopy (2020)	Sp. microscopy (2021)	NAAT (2019)	NAAT (2020)	NAAT (2021)	COVID Testing (2020)	COVID Testing (2021)
Chennai	128267	45977	52899	46598	24682	27481	257342	514685
Coimbatore	36559	18570	27256	9983	6927	7719	91652	183304
Cuddalore	29621	13415	16405	5664	3863	3861	64595	129190
Dharmapuri	18868	11005	14275	5530	4670	5485	51674	103348
Dindigul	32463	24668	29544	6257	5150	13375	103179	206359
Erode	18342	8052	7444	4781	4090	5666	40445	80889
Kancheepuram	47007	24887	27497	11133	10149	12486	113620	227241
Kanyakumari	31340	17431	27181	7650	4452	6111	84775	169549
Karur	11298	7040	11578	4320	3997	4487	36574	73147
Krishnagiri	22075	16867	18475	4444	4400	3792	63286	126573
Madurai	35310	17424	23018	9635	8903	7343	84668	169335
Nagapattinam	11670	8823	22594	6949	4381	5466	50719	101438
Namakkal	23485	14875	19120	6314	4201	6478	66302	132604
Perambalur	18014	11897	13284	4973	5307	6301	51880	103761
Pudukottai	18335	9771	15653	5186	5337	5844	51535	103070
Ramanathapuram	17008	12077	17213	4428	3855	5449	54314	108627
Salem	38782	20656	23935	12466	7847	10004	94944	189889
Sivagangai	15750	10700	16998	4531	4504	5647	51585	103169
Thanjavur	27519	15943	21354	4907	2894	4956	71529	143058
The Nilgiris	12279	5084	5662		3425	2866	27742	55483
Theni	13024	6891	9736	4190	3101	2733	33937	67875
Tirunelveli	30100	15618	21438	11287	5727	8118	76873	153746
Tiruvallur	35177	21668	26112	6793	4516	3803	92574	185148
Tiruvarur	15193	8352	10960	5232	5261	6090	40137	80274
Tiruppur	31207	18030	20627	8112	5042	6884	79427	158855
Tiruvannamalai	32675	23516	24734	7025	6894	8243	89849	179697
Tiruchirappalli	35649	20434	18725	7017	5798	7694	83384	166768
Tuticorin	16519	9593	13011	10790	6921	6695	46852	93704
Vellore	46842	24823	36850	10521	8569	10953	121113	242226
Villupuram	61746	44016	48345	10532	6031	7736	166626	333251
Virudhunagar	14001	8284	11495	6039	4775	6070	41182	82363
Total	926125	516387	653418	66186	159650		2323693	4647386

(Source: Annexure M, CBNAAT and Truenat register and COVID data shared by the State health department)

Annexure 11: ACF across 31 NTEP districts during Pre-COVID and COVID years

	Target population		Screened		Evaluated Sp. microscopy		Diagnosed TB	
Districts	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID
CHENNAI	886690	602615	107084	142775	7648	13043	151	245
COIMBATORE	946546	226860	64619	75779	2274	2807	68	98
CUDDALORE	210567	61739	54614	15173	759	1132	68	118
DHARMAPURI	130069	128673	87544	87043	2490	2345	59	79
DINDIGUL	12698	186305	2518	37338	451	2962	34	629
ERODE	49312	36895	30113	11324	448	487	35	84
KANCHEEPURAM	78537	198628	49005	26984	1345	1690	94	101
KANNIYAKUMARI	520321	443712	37646	206062	1144	5523	4	55
KARUR	52300	86015	26611	54732	901	884	97	71
KRISHNAGIRI	36026	40380	17244	18432	738	1376	39	46
MADURAI	154505	92720	104873	56220	2111	2067	108	179
NAGAPATTINAM	8167	40861	2762	24409	308	1661	12	56
NAMAKKAL	253181	111248	178039	79429	3106	1600	141	51
PERAMBALUR	46505	73667	19868	35273	1159	2910	46	140
PUDUKKOTTAI	27957	132842	12498	44005	411	1246	21	46
RAMANATHAPURAM	51476	103186	17294	17054	1222	1540	29	58
SALEM	101180	300917	30973	87162	837	3031	68	109
SIVAGANGA	35291	298042	13952	38601	337	685	36	36
THANJAVUR	178810	30179	47843	13027	614	1085	23	41
THE NILGIRIS	70881	29939	20113	11657	762	1510	0	6
THENI	1368	126101	561	16187	36	1350	2	79
THIRUVALLUR	84908	46605	36505	10865	3118	1258	47	30
THIRUVARUR	87774	116841	5389	30350	1862	1597	58	34
THOOTHUKUDI	34665	98096	29781	82633	701	1817	26	78
TIRUCHIRAPPALLI	11780	73070	2479	7073	197	690	9	94
TIRUNELVELI	0	72895	0	34936	0	1109	0	119
TIRUPPUR	99376	126189	24901	71297	746	1369	27	34
TIRUVANNAMALAI	103508	40789	53718	21558	2392	1326	161	26
VELLORE	46075	96678	23827	73348	784	3022	45	133
VILUPPURAM	422596	313702	290711	76907	9956	6096	485	369
VIRUDHUNAGAR	11315	74487	260	33746	260	1705	9	116

(Source: ACF registers)

Annexure 11b: ACF across 31 NTEP districts during Wave and Non-wave periods in 2020, 2021

	Target population		Screened		Evaluated Sp. microscopy		Diagnosed TB	
Districts	Wave	Non-wave	Wave	Non-wave	Wave	Non-wave	Wave	Non-wave
CHENNAI	63077	539538	10066	132709	1466	11577	53	192
COIMBATORE	1786	225074	116	75663	10	2797	2	96
CUDDALORE	6356	55383	907	14266	73	1059	9	109
DHARMAPURI	2617	126056	1343	85700	65	2280	1	78
DINDIGUL	1429	184876	1189	36149	103	2859	25	604
ERODE	0	36895	0	11324	0	487	0	84
KANCHEEPURAM	25509	173119	6590	20394	280	1410	18	83
KANNIYAKUMARI	2712	441000	1534	204528	46	5477	1	54
KARUR	2816	83199	1853	52879	24	860	3	68
KRISHNAGIRI	50	40330	20	18412	7	1369	0	46
MADURAI	0	92720	0	56220	0	2067	0	179
NAGAPATTINAM	68	40793	8	24401	1	1660	0	56
NAMAKKAL	18576	92672	10185	69244	133	1467	4	47
PERAMBALUR	20279	53388	7656	27617	612	2298	32	108
PUDUKKOTTAI	0	132842	0	44005	0	1246	0	46
RAMANATHAPURAM	4707	98479	502	16552	57	1483	5	53
SALEM	1451	299466	211	86951	54	2977	5	104
SIVAGANGA	4700	293342	3658	34943	35	650	2	34
THANJAVUR	2567	27612	83	12944	83	1002	2	39
THE NILGIRIS	104	29835	56	11601	10	1500	0	6
THENI	0	126101	0	16187	0	1350	0	79
THIRUVALLUR	7070	39535	175	10690	125	1133	2	28
THIRUVARUR	0	116841	0	30350	0	1597	0	34
THOOTHUKUDI	0	98096	0	82633	0	1817	0	78
TIRUCHIRAPPALLI	7301	65769	542	6531	67	623	3	91
TIRUNELVELI	0	72895	0	34936	0	1109	0	119
TIRUPPUR	473	125716	236	71061	128	1241	0	34
TIRUVANNAMALAI	5061	35728	3673	17885	245	1081	2	24
VELLORE	0	96678	0	73348	0	3022	0	133
VILUPPURAM	51972	261730	29352	47555	1008	5088	74	295
VIRUDHUNAGAR	0	74487	0	33746	0	1705	0	116

(Source: ACF registers)

Annexure 12: Cascade of contact tracing indicators during Pre-COVID and COVID years

	Total patients		Contact tracing		No. of HH Contacts		No. of HH Contacts screened for TB		No. with TB symptoms		No. evaluated with TB		No. diagnosed on TB		No. initiated on TB treatment	
Districts	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID
CHENNAI	31452	24426	17267	20550	47194	44845	40113	42931	3599	4424	3152	4073	815	219	163	98
COIMBATORE	9799	7384	5840	7024	15379	14739	8448	14398	209	167	151	151	24	15	18	10
CUDDALORE	6105	4432	2598	3824	8420	9493	5626	7921	297	168	175	106	107	31	68	29
DHARMAPURI	3639	2774	2735	2643	8676	7176	8236	7116	53	128	27	108	6	8	7	8
DINDIGUL	6520	5340	2641	5025	7684	11071	6648	10217	139	61	96	45	54	32	18	24
ERODE	8614	5201	5043	5115	13692	10702	11312	10452	99	62	64	50	8	5	9	5
KANCHEEPURAM	12609	10146	6522	8514	20074	19592	17262	18987	597	533	326	444	98	24	68	14
KANNIYAKUMARI	3344	2338	1922	2282	5940	5421	5088	5169	162	134	75	120	11	8	13	8
KARUR	2290	1606	1140	1582	3217	3726	2866	3662	25	15	18	14	10	7	7	6
KRISHNAGIRI	3865	2553	1445	2315	3404	4487	2525	3932	82	425	52	368	13	5	13	5
MADURAI	14760	8936	5782	7520	16452	16574	11642	15635	139	79	74	62	45	29	23	23
NAGAPATTINAM	3617	2487	2237	2149	6945	6217	6364	5933	394	690	294	584	26	7	18	2
NAMAKKAL	4030	2775	2431	2722	6309	5552	5833	5497	33	7	18	5	3	3	3	3
PERAMBALUR	3498	2763	1717	2692	5077	6008	4096	4191	18	24	3	15	0	7	1	8
PUDUKKOTTAI	3267	2446	1100	2370	3945	6317	3208	5709	30	10	22	2	5	2	2	10

RAMANATHAPURAM	4334	2934	1184	2650	3947	6569	3708	6536	86	53	44	30	15	23	22	23
SALEM	9480	6542	4510	6403	13152	15558	11999	15355	196	89	89	43	36	28	21	27
SIVAGANGA	3999	3008	1932	2955	5878	8119	5529	8086	74	55	60	44	28	14	28	14
THANJAVUR	7788	5362	3562	4991	13005	13168	10574	12358	155	46	90	38	79	13	72	16
THE NILGIRIS	612	378	483	374	1458	995	1381	991	38	20	27	19	9	14	9	14
THENI	4218	3088	2930	2923	8632	7447	7414	7245	178	50	121	26	104	16	96	11
THIRUVALLUR	4570	2966	2990	2896	9095	7405	8502	7335	560	510	480	489	60	66	43	39
THIRUVARUR	2962	2217	2032	2164	6273	5195	5610	5172	42	199	27	138	13	10	10	10
THOOTHUKUDI	5482	3783	2785	3424	8023	9022	7376	8903	49	42	32	36	22	18	19	16
TIRUCHIRAPPALLI	9929	5879	3865	5307	11986	13679	6145	10809	201	277	60	101	36	70	31	40
TIRUNELVELI	9017	6308	3804	5859	10795	12999	6614	10988	133	68	82	35	55	24	46	24
TIRUPPUR	4775	3824	2815	3685	7462	7625	7040	7528	310	423	244	384	21	14	18	12
TIRUVANNAMALAI	4671	3363	2832	3291	9002	8762	7609	8255	88	73	68	55	107	18	26	11
VELLORE	10538	9021	5398	6071	16835	15842	15894	15649	530	543	87	146	53	62	25	35
VILUPPURAM	5690	4703	3447	4162	10649	10411	7636	8640	446	450	253	395	143	38	42	31
VIRUDHUNAGAR	7058	4650	2920	4478	7395	10115	4553	10045	136	102	107	98	45	31	39	30
	212532	153633	107909	137960	315995	324831	256851	305645	9098	9927	6418	8224	2051	861	978	606

(Source: Contact tracing registers)

Annexure 12b: Cascade of contact tracing indicators during Wave and Non-wave periods in COVID years

	Total patients		Contact tracing		No. of HH Contacts		No. of HH Contacts screened for TB		No. with TB symptoms		No. evaluated with TB		No. diagnosed on TB		No. initiated on TB treatment	
Districts	Wave	Non-wave	Wave	Non-wave	Wave	Non-wave	Wave	Non-wave	Wave	Non-wave	Wave	Non-wave	Wave	Non-wave	Wave	Non-wave
CHENNAI	9580	14846	98	158	16679	28271	16052	26983	1905	2519	1760	2313	96	123	38	60
COIMBATORE	2959	4425	10	19	5282	9461	5205	9197	38	129	35	116	5	10	3	7
CUDDALORE	1761	2671	24	57	3454	6048	2884	5045	49	119	31	75	18	13	18	11
DHARMAPURI	1057	1717	10	10	2438	4738	2432	4684	45	83	40	68	3	5	3	5
DINDIGUL	2090	3250	17	49	3846	7228	3669	6548	31	30	25	20	20	12	12	12
ERODE	1906	3295	5	9	3381	7321	3342	7110	10	52	8	42	2	3	2	3
KANCHEEPURAM	3909	6237	16	22	6509	13095	6296	12703	212	321	181	263	5	19	2	12
KANNIYAKUMARI	837	1501	10	12	1725	3696	1663	3506	39	95	36	84	0	8	0	8
KARUR	578	1028	7	10	1217	2509	1205	2457	1	14	1	13	0	7	0	6
KRISHNAGIRI	1025	1528	5	9	1673	2814	1400	2532	197	228	163	205	4	1	4	1
MADURAI	3330	5606	24	40	5565	11014	5369	10270	20	59	19	43	9	20	9	14
NAGAPATTINAM	1036	1451	1	4	2524	3693	2371	3562	255	435	181	403	2	5	1	1
NAMAKKAL	1054	1721	3	5	1798	3754	1775	3722	2	5	2	3	2	1	2	1
PERAMBALUR	995	1768	8	10	1667	4341	1147	3044	9	15	6	9	0	7	0	8

PUDUKKOTTAI	908	1538	11	11	2190	4127	2054	3655	1	9	1	1	1	1	1	9
RAMANATHAPURAM	1099	1835	22	45	2103	4466	2093	4443	25	28	13	17	9	14	9	14
SALEM	2436	4106	26	50	5080	10484	5045	10316	19	70	9	34	8	20	8	19
SIVAGANGA	1153	1855	11	27	2925	5195	2916	5171	14	41	14	30	4	10	4	10
THANJAVUR	2083	3279	16	28	4480	8688	4169	8189	11	35	9	29	7	6	7	9
THE NILGIRIS	157	221	11	28	360	635	360	631	8	12	8	11	8	6	8	6
THENI	1108	1980	14	12	2280	5167	2184	5061	18	32	5	21	4	12	4	7
THIRUVALLUR	1107	1859	52	44	2515	4893	2473	4865	186	324	172	317	31	35	13	26
THIRUVARUR	896	1321	15	13	1812	3383	1804	3368	95	104	53	85	2	8	2	8
THOOTHUKUDI	1491	2292	16	31	3585	5441	3530	5377	23	19	20	16	11	7	11	5
TIRUCHIRAPPALLI	2261	3618	46	64	4732	8952	3752	7062	114	163	23	78	17	53	17	23
TIRUNELVELI	2318	3990	24	34	4422	8583	3785	7209	26	42	12	23	9	15	9	15
TIRUPPUR	1542	2282	15	15	2708	4917	2666	4862	176	247	160	224	3	11	3	9
TIRUVANNAMALAI	1317	2046	12	18	3015	5747	2854	5401	26	47	14	41	0	18	0	11
VELLORE	3470	5551	34	63	5449	10393	5394	10255	129	414	36	110	20	42	13	22
VILUPPURAM	1797	2906	30	59	3562	6849	2898	5742	161	289	124	271	23	15	22	9
VIRUDHUNAGAR	1766	2884	28	51	3816	6299	3814	6231	39	63	37	61	13	18	13	17
	59026	94607	621	1007	112792	212202	106601	199201	3884	6043	3198	5026	336	525	238	368

(Source: Contact tracing registers)