

**ASSESSING GAPS ACROSS THE TUBERCULOSIS CARE CASCADE: A
COMPREHENSIVE ANALYSIS OF CURRENT SITUATION OF
TUBERCULOSIS IN INDIA**

Dissertation Submitted to



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Master of Business Administration (MBA)
in
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By

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Under the Supervision and Guidance of

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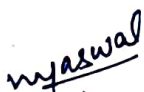
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I hereby declare that this dissertation titled **Assessing Gaps Across the Tuberculosis Care Cascade: A Comprehensive Analysis of Current Situation of Tuberculosis in India** is the Bonafide record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published and unpublished work of others has been duly acknowledged in the text.


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Dr. Muskan Jaswal

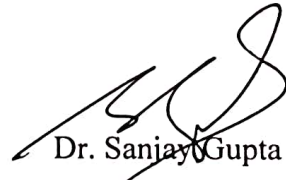
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CERTIFICATE

This is to certify that dissertation titled Assessing Gaps Across The Tuberculosis Care Cascade: A Comprehensive Analysis Of Current Situation Of Tuberculosis In India is a record of the research work undertaken by **Dr. Muskan Jaswal** in partial fulfilment of the requirements for the award of the degree of MBA (Hospital and Health Management) from the IIHMR University, Jaipur under my guidance and supervision and her approach to the research study has been sincere, scientific, and analytical.



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ABSTRACT

Tuberculosis (TB) remains a significant public health challenge in India, a country with one of the highest TB burdens in the world. The disease's complexity is exacerbated by systemic barriers, socio-economic factors, and co-morbid conditions that hinder effective management and control. This study aims to provide a comprehensive analysis of TB prevalence across Indian states, identify gaps in the TB care cascade, and propose evidence-based strategies to address these gaps. By examining the latest data from the India TB Report 2023 and conducting an extensive review of relevant literature, the study seeks to highlight the critical areas where interventions are needed to improve TB care outcomes. The goal is to contribute to the national objective of eliminating tuberculosis by 2025 through enhanced diagnostic infrastructure, better treatment adherence, and integrated healthcare services.

Study Objective

1. To analyze TB prevalence across Indian states using the latest India TB Report and identify regions with the highest burden.
2. To analyze gaps in the TB care cascade, including screening, diagnosis, treatment initiation, adherence, and follow-up.
3. To identify evidence-based strategies to address gaps in the TB care cascade.

Methodology

This study utilized a descriptive analysis of tuberculosis (TB) indicators from the India TB Report 2023, supplemented by a review of literature. The review of literature involved comprehensive data collection from sources such as PubMed, NCBI peer-reviewed journal articles, news articles, TB India Reports, and the National Strategic Plan. Data collection spanned from March 18th to June 25th, employing secondary data methods. Microsoft Excel was used for data analysis, focusing on indicators like TB incidence, treatment success rates, and patient retention rates to evaluate and identify gaps in the TB care cascade.

Key Results

The analysis revealed fluctuations in TB prevalence from 2016 to 2022, with a significant disruption due to the COVID-19 pandemic. In 2022, India reported a record

high of 2.42 million TB notifications, demonstrating the healthcare system's resilience. State-wise differences were noted, with Delhi having the highest notification rate and Kerala the lowest. The financial burden on TB-affected households remained significant, with up to 36% facing catastrophic expenses in 2021. Co-morbid conditions like diabetes, tobacco use, and HIV further complicated TB management, with over 2 million cases among HIV-positive individuals in 2022. The study highlighted significant gaps in the TB care cascade, particularly in follow-up procedures for household contacts of pulmonary TB patients, and identified the need for enhanced treatment adherence, better follow-up protocols, and improved integration between public and private healthcare sectors.

Conclusion

The study underscores the need for a concerted effort to remove systemic barriers, enhance financial protection, and ensure comprehensive care to achieve the goal of eliminating tuberculosis in India by 2025. Continuous public awareness campaigns, expansion of diagnostic infrastructure, and integration of health services are crucial. Targeted interventions, such as Tuberculosis Preventive Treatment (TPT) for household contacts, are essential to curb TB transmission and progression. Collaborative efforts between healthcare sectors, community organizations, and policymakers are vital for creating an integrated and effective TB care system.

Keywords

Tuberculosis, TB care cascade, India, TB prevalence, financial burden, healthcare system, co-morbidities, Catastrophic expenditure, Household contacts HHC, public awareness, diagnostic infrastructure, Tuberculosis Preventive Treatment (TPT).

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TABLE OF CONTENT

Contents

ABSTRACT	6
ACKNOWLEDGMENT	8
INTRODUCTION.....	13
1.1 Overview	13
1.2 Causes of TB	13
1.3 Symptoms of TB.....	Error! Bookmark not defined.
1.4 Global Scenario	14
1.5 Scenario in India.....	14
1.6 Aim	17
1.7 Objectives	17
RATIONALE OF THE STUDY	18
METHODOLOGY	28
DISCUSSION	45
CONCLUSION	50
REFERENCES.....	52

LIST OF FIGURES

Figure 5.1 Trend of TB Prevalence in India (2017-2022).....	30
Figure 5.2 State wise TB case notification rates for 2022	31
Figure 5.3 Catastrophic expenditure for TB treatment	33
Figure 5.4 TB notified patients with comorbidities	34
Figure 5.5 Steps of the TB care cascade and gaps across each step	35
Figure 5.6 Patients drop out at each stage of care cascade	37
Figure 5.7 Gaps in the TB care cascade in India at each step	38
Figure 5.8 Distribution of Household Contacts (HHC) of Pulmonary Bacteriologically (PBCT) by State	40

LIST OF TABLES

Table 1.1 Care cascade and treatment outcome of notified patients in 2022	36
Table 5.2 State-wise HHC Screening and Treatment Outcomes for Pulmonary Bacteriologically Confirmed TB Patients (PBCT) in India, 2022	39
Table 5.3 Limitations of present estimations and suggestions for enhancing the situation of India's tuberculosis cascade of care. (15).....	40

ABBREVIATIONS

TB	Tuberculosis
TBI	TB Infection
HIV	Human immunodeficiency viruses
AIDS	Acquired immunodeficiency syndrome
COVID-19	Coronavirus disease 2019
MDR-TB	Multidrug-resistant tuberculosis
SDGs	Sustainable Development Goals
RNTCP	Revised National Tuberculosis Control Program
NTEP	National Tuberculosis Elimination Program
DOTS	Directly Observed Treatment Short-Course
WHO	World Health Organization
HHC	Household Contacts
TPT	TB preventive treatment
NCBI	National Centre for Biotechnology Information.
Mohfw	Ministry of Health and Family Welfare
PLHIV	People living with HIV
UNAIDS	Joint United Nations Programme on HIV/Aids
PBCT	Pulmonary bacteriologically confirmed TB

CHAPTER 1

INTRODUCTION

1.1 Overview

The fight against TB remains one of the greatest challenges to public health in a country like India, bearing the highest burden of the disease worldwide. Even with huge efforts and headways in fighting it, TB remains a formidable threat to the health and well-being of millions of people. It takes a second in-depth review of current evidence that assesses the current situation of TB in India, its epidemiology, gaps in care cascade, and socio-economic impacts; challenges in meeting the set goals by eliminating this killer, TB, up to 2025(1).

1.2 Causes of TB

Initially, TB is an infectious disease and majorly it affects caused by a type of bacterium called mycobacterium tuberculosis. All this disease spreads from the infected person into the air these individuals cough, sneeze, or spit. Though treatable and preventable, TB calls for attention and care. Persons who harbor TB bacteria but are not yet ill do not transmit the disease. Normally, TB is treated using antibiotics, although the disease can be fatal if treatment goes without initiation.(2).

The BCG vaccine is given to infants and young children in some countries to protect against TB. This vaccine, while very good at preventing TB occurring outside the lungs from occurring, offers vital protection against the disease (3)(2).

1.3 Symptoms of TB

Latent TBI does not cause symptoms, and it is not contagious. Only a small proportion of individuals with TBI infection will progress to active TB disease, causing these symptoms, particularly in children and infants.

Common symptoms of active TB include:

- A prolonged cough sometimes blood is produced
- Weakness
- Fatigue
- Fever
- Night sweats
- Chest pain

The symptoms one experiences depend on which part of the body the TB bacteria affect.

This list includes some conditions that will increase one's risk of developing active TB:

- Diabetes (high blood sugar)
- Malnutrition
- Tobacco use
- Weakened immune system (from HIV or AIDS, for example)

When TB becomes active, as opposed to latent TB infections, symptoms appear. These symptoms can be very mild and last for months; besides, it is easy to spread the disease to others unintentionally. The fight against TB remains one of the greatest challenges to public health in a country like India, bearing the highest burden of the disease worldwide. Even with huge efforts and headways in fighting it, TB remains a formidable threat to the health and well-being of millions of people. It takes a second in-depth review of current evidence that assesses the current situation of TB in India, its epidemiology, gaps in care cascade, and socio-economic impacts; challenges in meeting the set goals by eliminating this killer, TB, up to 2025(2)((3).

1.4 Global Scenario

In 2022, TB caused the deaths of 1.3 million people, with 167,000 individuals who were HIV-positive. TB is the second leading infectious killer worldwide after COVID-19, surpassing HIV/AIDS.

Notably, about 10.6 million people developed TB infection in 2022, affecting 5.8 million men, and about 3.5 million women, and 1.3 million children. TB already affects people of all ages, countries, and is both preventable and treatable.

MDR-TB is one of the collisions of public health and emergencies. Only about 40 percent of patients with drug-resistant TB had been treated for it in the year 2022. Globally, an estimated 75 million lives have been saved from 2000 to date as a result of efforts to end TB. \$13 billion is annually called for if the ambitions set in the UN high level summit on TB in 2018 are to materialize in prevention, screening, diagnosis, treatment, and care for TB. One of the goals of the United Nations SDGs is to end the TB epidemic by 2030. (3).

1.5 Scenario in India

India contributes 25 percent of the world's burden of tuberculosis, and an estimated 2.6 million new cases come up, with nearly 450,000 deaths occurring every year due to this scourge. This mainly affects the most vulnerable sections of society—the poor, those living in overcrowded conditions, and persons whose immune systems are impaired, such as HIV patients. Contributing to the epidemiological complexity further, MDR-TB cases in the country are also quite considerable in number—in fact, India accounts for the maximum number of MDR-TB cases all over the world (3).

The healthcare system within India has, for the past decades, been in the trenches in this battle against TB. Of course, the RNTCP rolled out in 1997, along with its subsequent revamping in the form of NTEP, has been vital for the scaling-up of diagnostic and treatment services for TB in this country. There is integration of advanced diagnostic tools, that is GeneXpert and Line Probe Assay, into these programs, enlargement of the DOTS centers to ensure adherence to treatment. (1).

Despite these efforts, there are wide gaps. Most of the TB burden is treated by the private health sector, which often does not have uniformity in diagnostic and treatment practices. Besides, documentation in public health system is poor and overburdened leading to delays in diagnosis and the initiation of treatment. Improving these structural problems is key to better control of TB(4).

TB is an important socioeconomic concern for India. The disease affects mainly the productive years of a person's life, which not only significantly drains the economy of the affected families but also impacts the economy as a whole. Medical costs for diagnosis and treatment present the direct costs, while lost productivity, travel, and long-term incapacity make up for the indirect ones. (5). In India, the catastrophic expenditure for TB treatment was nearly 32% among the TB-affected households(6).

The socioeconomic impact is further exacerbated by the stigma associated with TB in regard to patient isolation, discrimination, and mental health problems. Reducing stigma by raising public awareness of the campaign and community involvement can help improve treatment adherence and decrease the social burden due to the disease(7).

Several challenges face TB control in India. The high prevalence of MDR-TB gives rise to a great threat, since MDR-TB requires more extended, expensive, and toxic treatment regimens. Other limitations to accessing quality TB care include infrastructure and human resource constraints, mainly in rural and remote areas(8). Furthermore, Comorbidities, such as diabetes and HIV, complicate the management and treatment course of TB.(2).

Another critical challenge is that TB cases are grossly underreported and under-diagnosed. Whereas diagnostic technologies have improved, asymptomatic nature during the staging period and limited awareness among the population means the majority of the cases continue to go undetected. Surveillance and case-finding strategies are critical to be intensified so as to bridge the gap(1) (4).

Despite this array of challenges, several opportunities and innovations could help speed up control efforts. Noting the political commitment by the government to ending TB by 2025—five years ahead of the global target—support from policy and funding to such a goal has been considerable (1) . Improved case detection and drug resistance surveillance could be enhanced by such new diagnostic tools as digital chest radiography and next-generation sequencing(9).

The WHO emphasizes that "patient-centered care for all people with TB" is an essential feature of their End TB plan implemented after 2015(1). The cascade of care model, as in the management of HIV, measures patient retention through the continuum of care to identify gaps and improve treatment quality. Unless one understands the challenges at each step of care, a robust approach to addressing these gaps within the TB care cascade in India cannot be formulated(10) (11).

There is a great risk of acquiring the disease among persons cohabiting with a pulmonary TB case patient, due to continuous exposure to the presence and closeness of the infectious case(12). Tracking of household contacts is one of the very important elements of TB control programs that emphasizes early detection and prompt action to stop transmission. This will entail the investigation of all the household contacts of the TB patient for latent TBI, with consequent prophylaxis. This can greatly reduce the burden of TB by breaking this chain of transmission (13).

Latent HHC TBI is transmitted through direct contact with a patient suffering from pulmonary TB, usually a family member living in the same home. It has been researched that within a year of diagnosis of an active TB patient, 75% of people infected with the disease become infected and within two years 97%. Indeed, molecular fingerprinting investigations have confirmed the odds of getting the disease within one, two, and five years are 45%, 62%, and 83%, respectively (14). Unfortunately, there are currently no markers that would allow differentiation of a newly acquired infection from a remote illness. TPT Specifics Accordingly, active TB must be screened out using the appropriate tests as guiding principle for the decision for a high-risk individual to qualify for TPT(15)

(16). Unfortunately, there are currently no markers that would allow differentiation of a newly acquired infection from a remote illness. TPT Specifics Accordingly, active TB must be screened out using the appropriate tests as guiding principle for the decision for a high-risk individual to qualify for TPT (14) .

The strategies are relevant to the implementation logic of the WHO's End TB Strategy, which estimates achieving 90% TPT coverage among people living with HIV and HHC of TB patients by 2025 (17). Implementation of TPT at household levels will significantly reduce the risk of spillage of TB infection and aid in containing the overall burden of TB (17) (16).

1.6 Aim

The aim of this study is to evaluate and address the challenges within the TB care cascade in India, identify high-prevalence states, analyze the financial burden on households, examine care pathway gaps, and propose targeted interventions to improve TB control and patient outcomes.

1.7 Objectives

4. To analyze TB prevalence across Indian states using the latest India TB Report and identify regions with the highest burden.
5. Identify gaps along the Tuberculosis care cascade: screening, diagnosis, treatment initiation, adherence, and follow-up.
6. Define evidence-based strategies to address gaps existing in the cascade of care in TB.

CHAPTER 2

RATIONALE OF THE STUDY

RATIONALE OF THE STUDY

The trend of Tuberculosis is very critical in the regarding to Public Health; one-fourth of the global burden of it resides in India. Extensive efforts are being done, and improvement is observed, but still, TB continues to be a serious health threat because of the continuous gaps in care continuum from diagnosis to treatment adherence with follow-up. Therefore, understanding the gaps is imperative for the implementation of some effective interventions.

High prevalence, burden: The high burden of TB in India is focused research that needs to identify the most affected states and explain regional disparities. This exercise uses the most recent data to give a precise mapping, resource allocation, and strategic planning.

Recent Trends and Changes: Trends in the data of the last few years give us an idea of how current measures are working and point out the changes that are starting to materialize. Such comparison will show whether effort regarding TB management is improving or going downhill, hence indicating where more attention needs to be paid. This will also give clues regarding the success of different treatments.

Gap Analysis: The study is being done to identify the causes of delay or inefficiency in the diagnosis, treatment, and follow-up stages of the care process. Systematic analysis of the gaps can allow focused and more effective strategies for improvement in TB care.

Targeted Interventions: Evidence-based strategies to bridge the gaps in such defects will highly improve patient outcomes and general control of TB. The key interventions relate to improved education of patients, making better diagnoses, and ensuring adherence to treatment in order to reduce incidence and mortality from TB.

This would be invaluable to the national and international quest for a world free from this scourge. The emphasis on these areas makes this study relevant to the goals set under India's National Strategic Plan for TB Elimination and the WHO End TB Strategy.

CHAPTER 3

REVIEW OF LITERATURE

Author	Methodology	Key Features
Subbaraman R, Nathavitharana RR, Satyanarayana S, Pai M, et al. (2016)	Systematic review and meta-analysis of public sector health data to construct care cascade of tb.	-Estimated how many patients suffering from TB ‘lost’ and did not receive effective treatment at each stage of care cascade. - For certain forms of TB, such as smear-negative TB and multidrug-resistant TB, increasing the detection and diagnosis of new patients utilizing cutting-edge TB diagnostic tests may be the most important strategy for improving patient outcomes. -The greatest strategies to improve outcomes of the patients for other types of TB patients, such as newly diagnosed smear-positive patients, may involve decreasing the number of patients who stop taking their medication as prescribed and increasing drug adherence to reduce the likelihood of recurrence.

Harsh D. Shah, Shalu Chaudhary, Bharat Desai, Jay Patel, et. al (2024)	Cross-sectional qualitative research using a grounded theory approach and thematic analysis.	-Poor health-seeking behavior influenced by socio-economic status and misinformation about TB. -Significant delays were noted in initial consultation due to patient behaviors and socio-economic factors. -Unavailability of diagnostic tests and high costs in the private sector contributed to delays. -Delays in starting treatment after diagnosis, particularly influenced by the cost and availability of tests.
Ramnath Subbaraman, Tulip Jhaveri, Ruvandhi R. Nathavitharana (2016)	Systematic review and observational cohort study	-The study focuses on identifying and addressing the gaps in the TB care cascade to improve patient outcomes and control the spread of the disease. -The impact of socio-economic factors, healthcare infrastructure, and policy gaps on the effectiveness of TB care.

Sandul Yasobant, Harsh Shah, Priya bhavsar, et al. (2023)	A cross-sectional assessment in two Indian states, Jharkhand, Gujarat	- According to the study, there are notable delays in the TB care cascade that affect more than half of patients with pulmonary TB and a far higher percentage of patients with extra-pulmonary TB. -Over half of patients with pulmonary tuberculosis and a greater proportion of patients with extra-pulmonary tuberculosis reported delays in the tuberculosis care cascade, namely during the initial phases of consultation, diagnosis, and treatment initiation. -Both patient-side factors (such as lack of awareness, addiction, and co-morbidities) and system-side issues (like inadequate case findings, poor diagnostic infrastructure, and adverse drug reaction management) contribute to these delays, highlighting the need for balanced strategies addressing both
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		service delivery and socio-cultural contexts.
Susmita Chatterjee, Palash Das, Guy Stallworthy, Gayatri Bhambure et.al (2024)	The study employs a combination of qualitative and quantitative research methods, including patient surveys and data analysis.	-Examines the financial burden of TB on patients living in India. -Analyzes the impact of different methodological choices on estimating catastrophic costs. -Focuses on direct and indirect costs incurred by patients. - Highlights the importance of consistent and accurate methodology in measuring financial impact. -Discusses policy implications for TB control programs
Tadayuki Tanimura, Ernesto Jaramillo, Diana Weil, Mario Raviglione, and Knut Lönnroth (2014)	Comprehensive review of existing literature and studies on TB-related costs.	-Identification of high out-of-pocket expenses faced by TB patients. -Estimation of catastrophic costs (costs exceeding a significant percentage of household income). -Impact of these financial burdens on treatment

		adherence and health outcomes.
Gargi Thakur, Shalvi Thakur, Harshad Thakur (2020)	Qualitative research involving interviews and surveys with stakeholders such as healthcare providers, policymakers, patients, and public health officials	-Identification of critical challenges in TB control, including gaps in healthcare infrastructure, diagnostic delays, and treatment adherence issues. -The impact of socio-economic factors, stigma, and lack of awareness on TB management. -Stakeholder insights on the effectiveness of current TB control strategies and areas needing improvement.
Andrew Courtwright and Abigail Norris Turner (2016)	Analysis focusing on TB-related stigma.	-Examines the pathways through which TB-related stigma impacts patients. - Identifies social, cultural, and economic factors contributing to stigma. - Discusses the consequences of stigma, such as delayed diagnosis and treatment non-adherence. - Suggests interventions to reduce stigma, including

		public health campaigns, community engagement, and supportive policies. - Highlights the importance of integrating stigma reduction strategies into TB control programs.
Harsh D. Shah, Mahalaqua Nazli Khatib, Zahiruddin Quazi Syed, Abhay M. Gaidhane et. al, (2022)	Qualitative review of existing literature on TB diagnosis and care.	-Identification of critical gaps in TB diagnosis at various stages, including patient delays in seeking care, community-level stigma, and systemic issues like inadequate diagnostic infrastructure. -The importance of patient education, community engagement, and strengthening healthcare systems to improve TB diagnosis and treatment outcomes.
P. Thekkur, R. Thiagesan, D. Nair, N. Karunakaran, M. Khogali, R. Zachariah, S. Dar Berger, et.al (2023)	Cross-sectional study by using timeliness metrics to evaluate HHC tracing and TB preventive therapy (TPT).	-Assessment of the efficiency and delays in tracing household contacts of TB patients. -Identification of barriers in promptly identifying and evaluating contacts. -Evaluation of the uptake and adherence to TB

		preventive therapy among household contacts. -Analysis of factors influencing the initiation and continuation of preventive therapy
Gregory J. Fox, Simone E. Barry, Warwick J. Britton, Guy B. Marks (2013)	Systematic review and meta-analysis of existing studies on TB contact investigation.	- Comprehensive review of contact investigation practices for TB. -Analysis of the effectiveness of contact tracing in identifying and treating secondary cases of TB. -Assessment of risk factors associated with TB transmission among contacts. -Evaluation of intervention strategies to improve contact investigation outcomes.
A.D. Harries, S. Satyanarayana, P. Kumar, S. Subbaraman, A. McClelland, R. Zachariah, R. Narayanan (2020)	Analysis of TB preventive treatment (TPT) implementation for household contacts of pulmonary TB patients in India.	- The study underscores the importance of providing TPT to all household contacts of pulmonary TB patients. - Evaluates the benefits of TPT in preventing the

		development of active TB among contacts. - Discusses the challenges and barriers to implementing TPT, including health system constraints and socio-economic factors. - Recommends strategies to improve TPT uptake and adherence, such as enhanced healthcare worker training, community awareness programs, and integration with existing TB control measures.
Banurekha Velayutham, Lavanya Jayabal, Basilea Watson, Saraswathy Jagadeesan, Dhanalakshmi Angamuthu, Priscilla Rebecca, Bella Devaleenal, Dina Nair, Srikanth Tripathy, Sriram Selvaraju (2020)	Prospective cohort study conducted in urban Chennai, India.	- Implementation of a structured contact screening card significantly improved TB screening among household contacts (HHC) from 36% to 80%. - Identified reasons for non-screening, such as feeling healthy, time inconvenience, and stigma. - Follow-up TB screening was conducted at 6 and 12 months, revealing an

		increase in identified TB cases and treatment initiation. -Emphasized the importance of systematic documentation and training for effective TB control. - Highlighted barriers like HCW non-availability and socio-economic factors affecting TB screening adherence.
Hashim, Zia; Tyagi, Richa; Singh, Gajendra Vikram; Nath, Alok; Kant, Surya (2024)	Review and analysis of existing literature and policy documents on latent TB preventive treatment in India.	- Emphasizes the need for preventive treatment for latent TB to control the spread of active TB. - Discusses the challenges and barriers in implementing preventive treatment, including patient adherence and healthcare infrastructure. - Highlights the success of preventive treatment programs in reducing TB incidence in high-risk populations.

CHAPTER 4

METHODOLOGY

4.1 Research Question

How can the challenges in the TB care cascade in India be effectively mitigated to enhance TB control and improve patient outcomes, particularly in high-prevalence states, while considering the financial burdens and gaps in care pathways?

4.2 Study Methodology

Study Design

This study employed a descriptive analysis of TB indicators using data from the India TB Report 2023 and a review of literature to analyze gaps across the TB care cascade in India. The approach involved a comprehensive review of existing literature and data sources, focusing on various stages of TB care, from diagnosis to treatment completion.

Data Sources

The data sources included:

- PubMed
- NCBI peer-reviewed journal articles
- News articles
- TB India Reports
- National Strategic Plan (2017-2021)

Duration of the Study

The study was conducted over a period of 100 days, from March 18th to June 25th.

Data Collection Method

Secondary data collection was employed, gathering existing data from the aforementioned sources to ensure a broad and detailed analysis of the TB care cascade in India.

Data Analysis Tool

Data was analyzed using Microsoft Excel. The selected indicators for analysis included:

- Statistical data on TB prevalence
- Treatment outcomes
- Gaps across the care cascade (drop offs)

These indicators provided a basis for evaluating the effectiveness of the TB care cascade and identifying critical gaps that require targeted interventions. The review of literature and descriptive analysis aimed to develop evidence-based strategies to enhance TB control and patient outcomes in India.

CHAPTER 5

RESULTS

The analysis of the India TB Report 2023 data uncovered notable fluctuations in tuberculosis prevalence across Indian states from 2016 to 2022. The COVID-19 pandemic caused a significant disruption in TB notifications, but by 2022, India had rebounded strongly, with a record high of 2.42 million TB notifications. This increase highlights the resilience and effectiveness of the healthcare system in recovering post-pandemic.

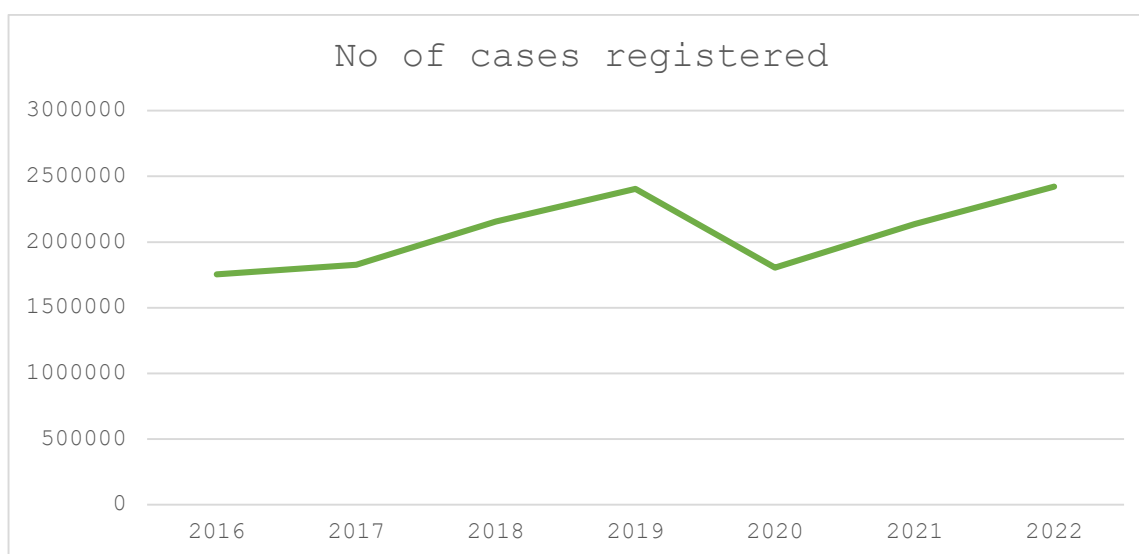


Figure 5.1 Trend of TB Prevalence in India (2017-2022)

Fig 5.1 illustrates the trend of TB prevalence in India from 2016 to 2022 based on the number of registered cases. In 2016, there were around 1.7 million registered TB cases. This number increased to around 1.8 million in 2017 and continued to rise significantly around 2.1 million in 2018 and 2.4 million in 2019. However, there was a notable decrease in 2020, likely due to the impact of the COVID-19 pandemic on healthcare services. The number of cases rose again to in 2021 and peaked at around 2.4 million in 2022. This trend highlights both the fluctuations in TB case registrations and the significant impact of the pandemic on TB diagnosis and reporting.

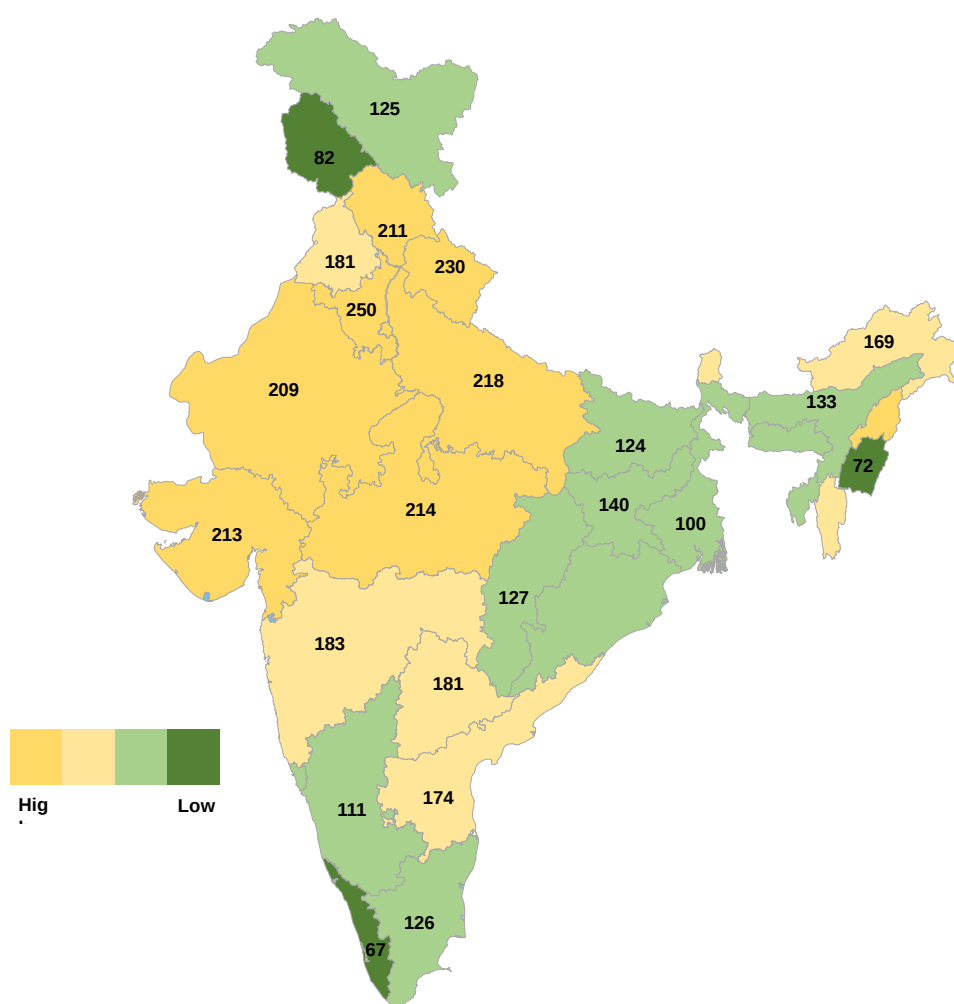


Figure 5.2 State wise TB case notification rates for 2022

Rate of Tuberculosis in All Indian States

The number of tuberculosis (TB) cases reported in India increased dramatically in 2022, hitting a new high of **2.42 million** cases. This translates to an anticipated notification rate of 172 instances per 100,000 persons, a 13% increase from 2021. Remarkably, 95.5% of these individuals started therapy, demonstrating the healthcare system's dedication to treating tuberculosis.

Notification Rates by State

The most recent India TB Report 2023's state-by-state research showed wide differences in TB notification rates:

With **546 cases** reported for every 100,000 persons, **Delhi** had the highest notification rate, indicating a significant TB prevalence.

High notification rates of **250 and 213** cases per 100,000 persons, respectively, were also recorded by **Maharashtra and Uttar Pradesh**, indicating a notable TB prevalence in these densely populated states.

Gujarat came next, registering **214** instances reported for per 100,000 residents, demonstrating the pervasiveness of tuberculosis in the area.

On the other hand, certain states saw **reduced rates of tuberculosis** notice, indicating improved oversight or reporting:

Kerala had the lowest incidence of notification (**67 cases** per 100,000 persons), suggesting that TB control and management measures are working.

Additionally, lower rates were recorded from **Mizoram and Jammu & Kashmir**, at 72 and 82 instances per 100,000 persons, respectively.

Regional Inequalities

The differences in TB notification rates between states show the different obstacles and achievements in TB management initiatives. While high-burden states like Delhi, Uttar Pradesh, Maharashtra, and Gujarat require more intensive interventions to lower TB prevalence, states like Kerala, Mizoram, and Jammu & Kashmir demonstrate successful TB treatment.

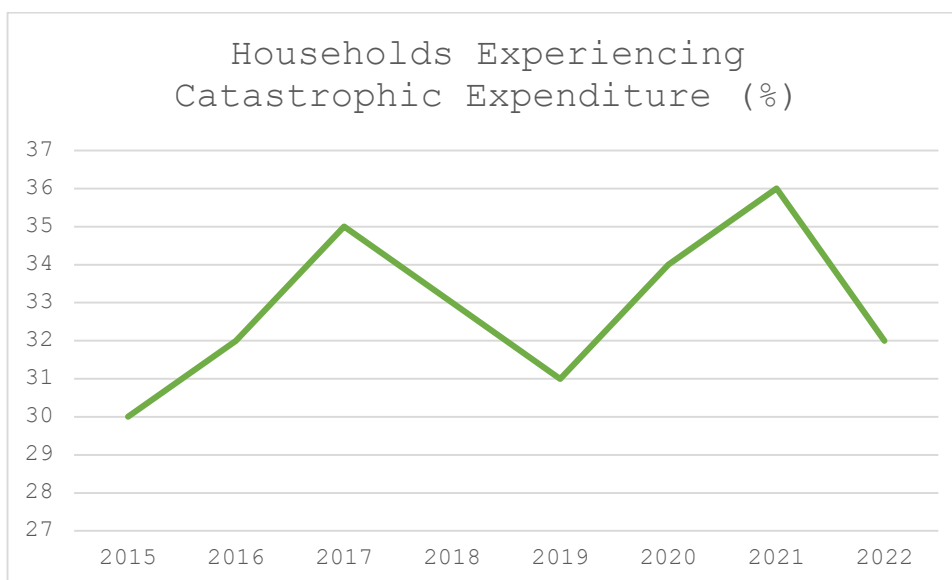


Figure 5.3 Catastrophic expenditure for TB treatment

The percentage of families facing catastrophic expenditures increased from 30% in 2015 to a peak of 36% in 2021, followed by a minor dip to 32% in 2022 (Fig: 5.3).

This indicates an overall growing trend in catastrophic expenditure for TB in India from 2015 to 2022. This pattern highlights the significant financial burden that TB places on households afflicted, which is probably caused by deficiencies in the healthcare system, rising healthcare expenses, and economic fragility. Households are nevertheless under financial difficulty due to extra costs associated with travel, nourishment, and missed income, even in spite of government efforts to offer free or subsidized TB treatment. The financial strain can affect health outcomes and exacerbate poverty by causing non-adherence to treatment, extended sickness, increased transmission, and the emergence of drug-resistant tuberculosis. The recent drop in 2022 can be a sign of advancements in healthcare access or financial safety nets. To address these issues and assist India's objective of eliminating tuberculosis by 2025, better financial protection, increased access to free services, community-based support, and public awareness campaigns are needed to lessen the economic effect of tuberculosis.

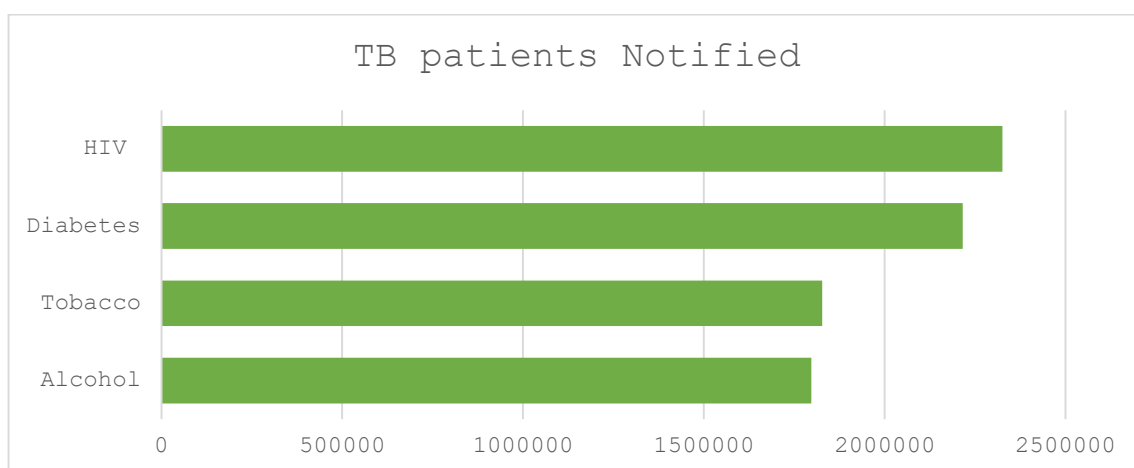


Figure 5.4 TB notified patients with comorbidities

The graph in Fig 5.4 indicates several key comorbidities that significantly impact TB notifications.

Diabetes increases the risk of developing TB by 2-3 times and leads to poorer treatment outcomes, including delayed microbiological conversion, higher rates of death and treatment failure, and increased risk of relapse after treatment completion.

In 2022, approximately 210,543 TB patients were identified as tobacco users, with 67,157 linked to tobacco cessation services. Alcohol use disorder is another important risk factor, with 74% of notified TB patients screened for alcohol consumption and 7.2% reporting alcohol use.

A particularly critical intersection highlighted in fig 5.4 is the substantial number of TB notifications among PLHIV, exceeding 2 million cases. HIV severely compromises the immune system, increasing a person's vulnerability to tuberculosis infection and the disease's evolution from latent to active forms. This co-infection is particularly concerning as TB remains a leading cause of death among PLHIV. The significant number of TB cases among this population underscores the urgent need for integrated health services that address both TB and HIV.

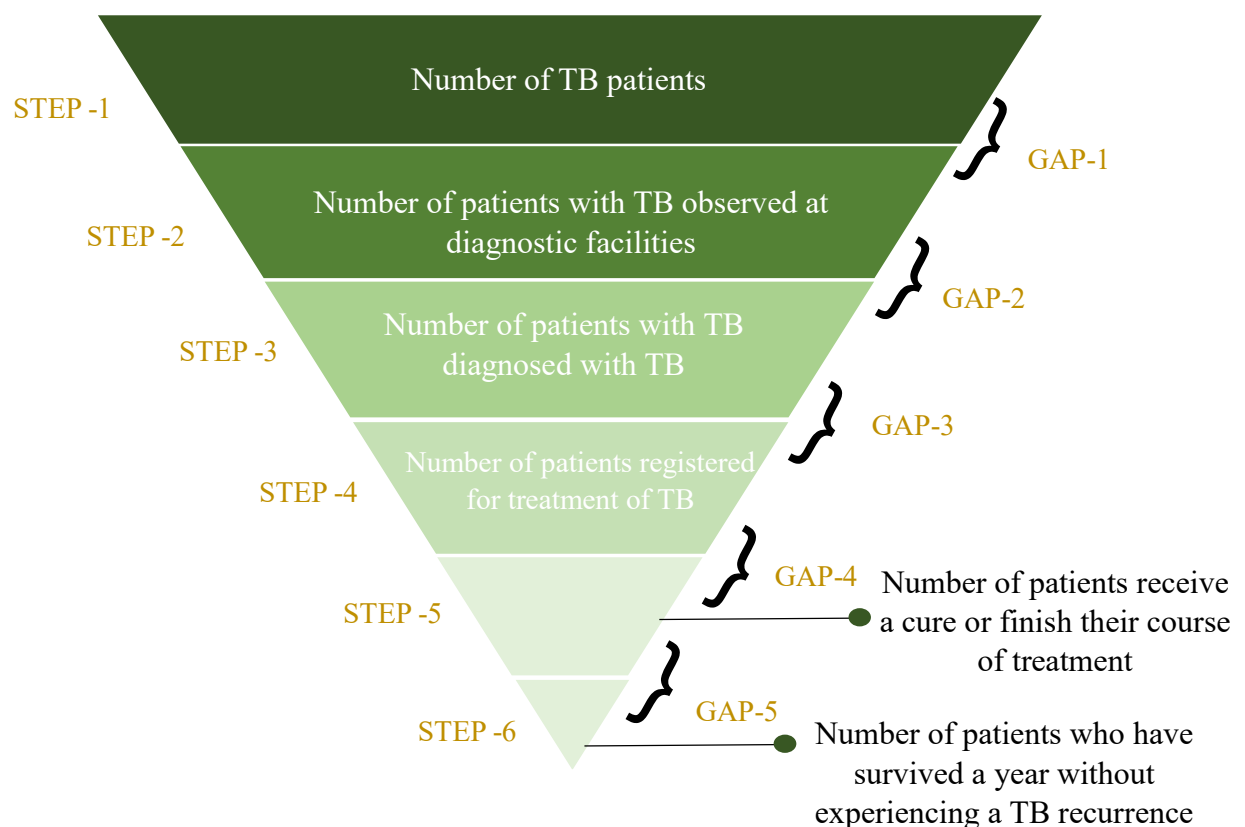


Figure 5.5 Steps of the TB care cascade and gaps across each step

Significant gaps exist across the TB care cascade (Fig 5.5). Many individuals lack awareness about TB symptoms, and structural barriers such as inadequate transportation and financial constraints hinder access to diagnostic facilities. Healthcare providers sometimes fail to effectively communicate the need for testing, leading to missed diagnoses.

Additionally, a significant number of diagnosed patients do not start treatment due to stigma, financial barriers, and early deaths caused by diagnostic delays. Addressing these gaps with targeted interventions and strengthening health systems is crucial for improving TB care and reducing its burden in India.

Table 5.1 presents the care cascade of treatment outcomes among notified TB patients in India for the year 2022, with large disparities and dropouts across public and private healthcare sectors.

Of the 2,082,444 TB patients notified, 1,527,464 were from public and 554,980 from private healthcare facilities. The overall cure rate was 27.8 per cent; it was considerably higher in the public sector, 35.8 per cent compared to 5.7 per cent in the private sector. Treatment success rate was not much different across various sectors: public sector 85 percent, private sector 86.7 percent, for an overall success rate of 85.5 percent. The concern, of course, is the high drop-out rates, 4.2% overall death rate, with the public sector at 4.5% slightly higher compared to the private one at 3.6%. Percentage of patients lost to follow-up was 2.6%, this also being higher in the private sector (3.4%) compared with the public sector (2.3%). Additionally, the treatment failure rate is 0.5%, with the public sector at 0.6% and the private sector at 0.4%.

These figures emphasize the need for improved treatment adherence, better follow-up mechanisms, and stronger integration between public and private healthcare services to reduce dropouts and enhance TB treatment outcomes in India.

Table 1.1 Care cascade and treatment outcome of notified patients in 2022

	Public	%	Private	%	Total	%
TB patients Notified	1527464		554980		2082444	
Cure Rate	547544	35.8	31494	5.7	579038	27.8
Success Rate	1298240	85	481362	86.7	1779602	85.5
Death Rate	67985	4.5	20075	3.6	88060	4.2
% Lost to follow up	35222	2.3	18905	3.4	54127	2.6
Treatment Failure Rate	9259	0.6	2049	0.4	11308	0.5

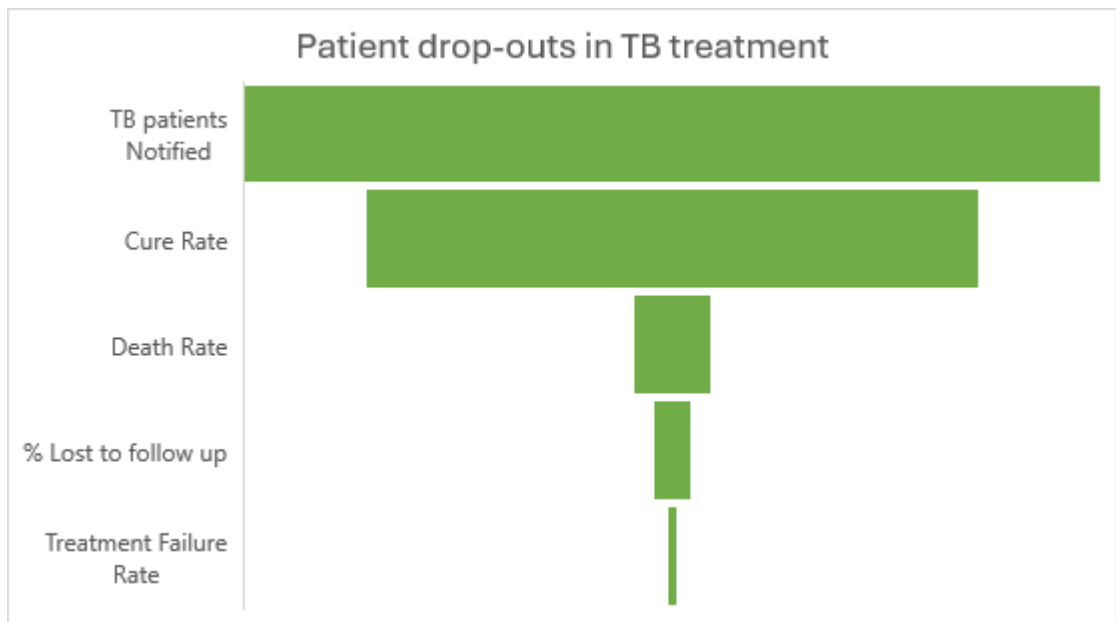


Figure 5.6 Patients drop out at each stage of care cascade

For people with active tuberculosis, a care cascade model is one in which each stage has a gap (those with poor outcomes, measured as the difference between steps) and a step (the number of people who reach that point in care) and gap between the steps.

The following gaps exist in the population: those with active TB who do not seek medical attention and obtain a tuberculosis diagnostic test (Gap 1); those who seek medical attention and access diagnostic tests but do not receive a successful diagnosis (Gap 2); those who receive a successful diagnosis but do not register for treatment (Gap 3); those who begin medication but do not receive successful treatment (Gap 4); and those who complete therapy but die or relapse within 12months (Gap 5) (Fig 5.7).

This approach has been vital in monitoring progress in global health initiatives, including the UNAIDS 90-90-90 strategy for HIV.

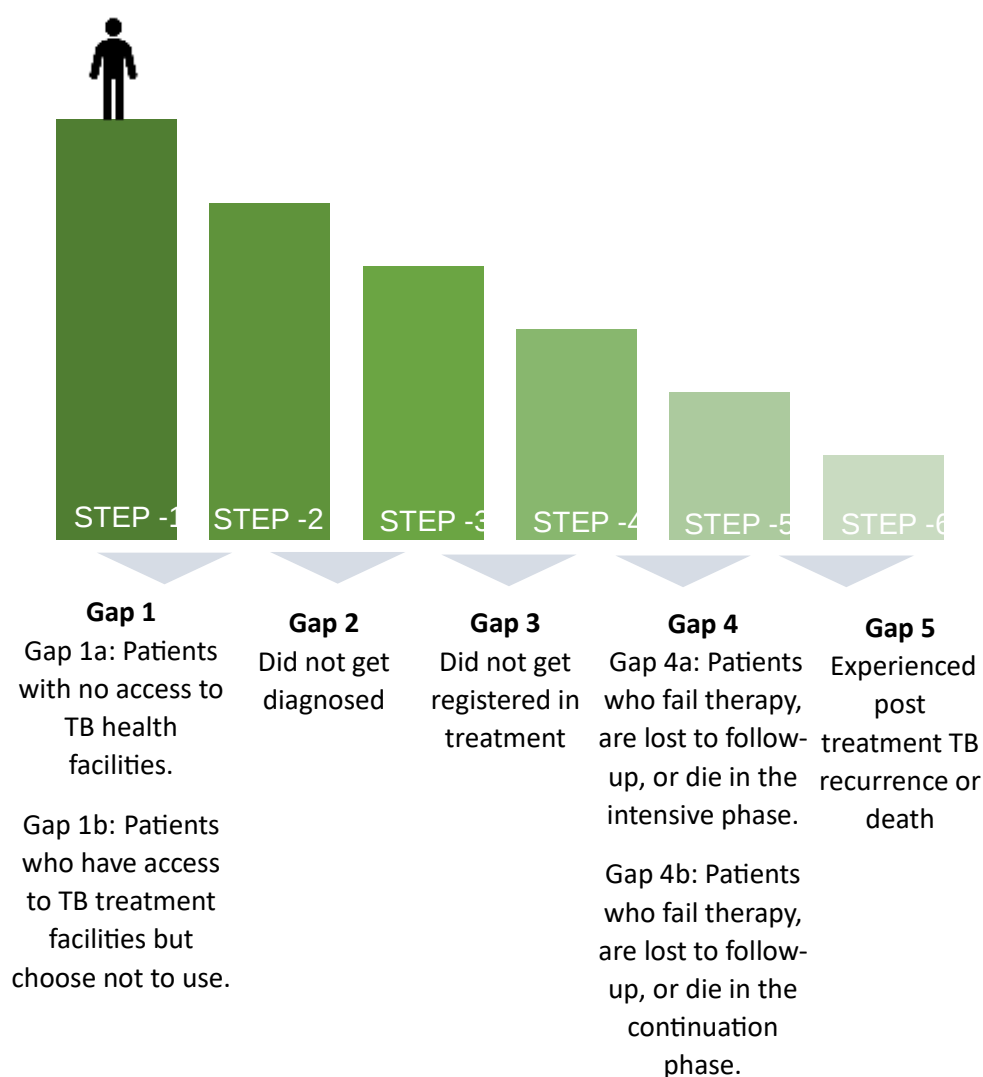


Figure 5.7 Gaps in the TB care cascade in India at each step

The table 5.2 provides a detailed overview of the management of household contacts (HHC) of pulmonary bacteriologically confirmed TB patients (PBCT) across various states in India. Uttar Pradesh stands out with the highest number of HHC at 845,733, highlighting a significant need for targeted interventions.

Screening efforts in Uttar Pradesh are robust, with 94% of HHC screened for TB. However, only 39% of those screened are evaluated for TB, and 74% of those diagnosed are put on treatment, indicating gaps in the follow-up process. The data underscores the critical need for Treatment for Preventive TB (TPT) to reduce the risk of TB transmission and progression among HHC.

Table 5.2 State-wise HHC Screening and Treatment Outcomes for Pulmonary Bacteriologically Confirmed TB Patients (PBCT) in India, 2022

State	No. of HHC of PBCT	No. of HHC of PBCT screened for TB	No. of HHC of PBCT symptomatic for TB	No. of HHC of PBCT evaluated for TB	No. of HHC of PBCT diagnosed with TB	No. of HHC of PBCT put on TB treatment	No. of HHC of PBCT provided TPT*
India	3356272	92%	2%	71%	41%	72%	24%
Uttar Pradesh	845733	94%	1%	39%	74%	80%	11%
Rajasthan	250376	94%	1%	58%	40%	51%	40%
Maharashtra	230636	93%	3%	82%	36%	92%	22%
Madhya Pradesh	221772	88%	1%	70%	56%	60%	37%
West Bengal	203273	95%	1%	66%	20%	50%	51%
Gujarat	173593	96%	3%	84%	12%	79%	36%
Bihar	132398	89%	1%	46%	77%	77%	19%

*After ruling out Active TB cases

Based on the data provided in the table 5.2 , in relation to the number of household contacts (HHC) receiving Preventive TB treatment (TPT) in India are

92% of HHC of pulmonary bacteriologically confirmed TB (PBCT) are screened for TB in India. 71% of those screened are evaluated for TB. 72% of diagnosed cases are put on TB treatment. 24% of HHC are provided TPT after ruling out active TB cases.

The Fig 5.8 illustrates the distribution of HHC of (PBCT) TB Patients across high prevalent Indian states. Uttar Pradesh has the largest share, accounting for 41% of the total HHC, indicating the highest burden. Maharashtra follows with 12%, while Rajasthan and Madhya Pradesh each represent 11%. West Bengal holds 10%, Gujarat 9%, and Bihar 6%. This visual representation highlights the significant variance in the number of HHC among states, emphasizing the need for targeted TB interventions in the highest burden areas like Uttar Pradesh.

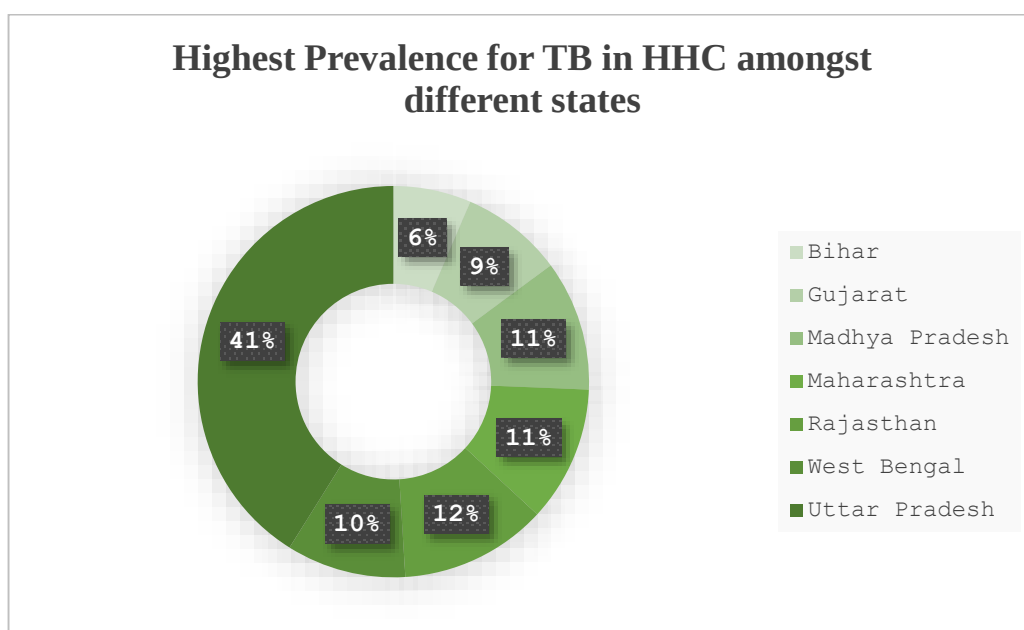


Figure 5.8 Distribution of Household Contacts (HHC) of Pulmonary Bacteriologically (PBCT) by State

Table 5.3 Limitations of present estimations and suggestions for enhancing the situation of India's tuberculosis cascade of care. (15)

Gaps	Limitation	Recommendation
Gap-1 It is estimated that only 68% of the estimated 2.84 million new TB cases get tested for TB	Barriers to case detection include: • limited awareness about TB symptoms. • Low healthcare-seeking behavior. • Inadequate access to quality diagnostic services, especially in remote and underserved areas.	Public Awareness Campaigns: Conduct targeted public awareness campaigns to educate the general population about TB symptoms, risk factors, and the importance of seeking medical attention if symptoms persist. Community Outreach: Engage with local

		community leaders and religious organizations to raise awareness about TB and encourage healthcare-seeking behavior. Access to Quality Diagnostic Services: Ensure that quality-assured diagnostic services are available and accessible, especially in remote and underserved areas.
Gap-2 It is estimated that only 57% of the estimated 2.84 million new TB cases are successfully diagnosed	Challenges at this stage include: • Limited availability of quality-assured diagnostic services. • poor sample collection and transportation. • Delays in test results.	Improved Diagnostic Infrastructure: Strengthen the diagnostic infrastructure by increasing the availability of quality-assured diagnostic services, including newer technologies like Xpert MTB/RIF. Sample Collection and Transportation: Improve sample collection and transportation systems to reduce delays in test results.

		Training for Healthcare Providers: Provide training to healthcare providers on the use of diagnostic tests and interpretation of results.
Gap-3 It is estimated that only 50% of the estimated 2.84 million new TB cases begin treatment .	Barriers to linkage to treatment include: • Lack of awareness about free TB treatment services. • financial constraints • poor coordination between the public and private healthcare sectors.	Awareness about Free TB Treatment Services: Educate patients about the availability of free TB treatment services and the importance of seeking timely treatment. Financial Support: Provide financial support to patients who cannot afford treatment, especially in marginalized populations. Coordination between Public and Private Healthcare Sectors: Improve coordination between the public and private healthcare sectors to ensure seamless linkage to treatment.
Gap-4 It is estimated that only 43% of the estimated 2.84	Factors contributing to poor treatment adherence include:	Patient Support: Provide social support to patients, including counseling and peer

million new TB cases complete their treatment .	• Side effects of lack of social support and medications • Challenges in accessing treatment services, especially for marginalized populations.	support, to enhance treatment adherence. Treatment Adherence Monitoring: Implement regular treatment adherence monitoring to identify and address adherence issues early. Access to Comprehensive Care: Ensure that patients have access to comprehensive care, including treatment for comorbidities and drug-resistant TB.
Gap-5 It is estimated that only 37% of the estimated 2.84 million new TB cases achieve this outcome.	Challenges at this stage include: • High rates of post-treatment TB recurrence • Inadequate follow-up • Limited access to comprehensive care for patients with comorbidities or drug-resistant TB.	Follow-up Care: Ensure that patients receive regular follow-up care to monitor treatment outcomes and detect recurrence early. Comprehensive Care for Comorbidities: Provide comprehensive care for patients with comorbidities, including treatment for associated conditions.

		Drug Resistance Surveillance: Implement drug resistance surveillance to monitor and address the emergence of drug-resistant TB.
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CHAPTER 6

DISCUSSION

The study highlights both progress and ongoing challenges in the fight against tuberculosis (TB). The World Health Organization's 2022 According to the Global Tuberculosis Report, most high-burden TB nations have seen an increase in TB fatalities since COVID-19 began, in part because fewer new cases are being detected (18). In India, the TB burden has oscillated between 2016 and 2022, influenced to a large degree by a pandemic that disrupted health care. (18). Despite wide-scale disruption, India reached an all-time high in TB notifications during 2022, with 2.42 million cases reported—the health system resilience in case detections and reporting came out strong. The very same resilience underlines the potential of the system to adapt continuously and pursue the control of TB despite external disturbances. (19) (20)(21)(22) (23).

State-wise variations in case notification rate range from a high of 547 in Delhi to a low of 67 in Kerala, underscoring the fact that region-specific strategies for enhancing TB detection and management are required. (19). There are so many disparities that call for tailoring the approaches to the regions under study, realizing that very diverse regions do not allow the application of a one-size-fits-all strategy. The NTEP, earlier called the Revised National Tuberculosis Control Programme has played a significant role in bridging these gaps by way of focussed interventions and state-specific action plans. (1).

The economic cost to households affected by TB remains very high with catastrophic expenditures as high as 36% of families affected in 2021 (6). Chatterjee et al. demonstrated that delays from the onset of symptoms to the start of therapy (accounting for 44% to 59% of the overall cost of care) were major contributors to catastrophic expenses (24). Achieving universal health coverage includes financial risk protection; thus, comprehensive data on expenses, catastrophic costs, and other economic impacts of TB are necessary to establish social protection measures. By measuring the catastrophic costs of tuberculosis for a representative sample of the Indian population, the government will be better equipped to address demand-side cost barriers and the techniques used to

mitigate them. This is crucial for policy decisions aimed at reaching the zero catastrophic cost target outlined in the End TB plan, intended to be achieved by 2020 (1).

According to Gursimrat et al.'s study, those who co-infect with HIV and TB have a 20–40 times higher risk of developing active TB in the same nation than HIV-negative people. Tb is the most common HIV-associated opportunistic disease in the world accounts for more than 25% of the 2 million AIDS-related deaths in 2008 The co-infection severely compromises immune status, enhancing an individual's chance of acquiring a TB infection and latent progressing to active TB. This is highly concerning as TB remains the leading cause of death. This is especially alarming because TB continues to be the primary cause of mortality for individuals living with HIV (PLHIV) (19) (25).

Among 2,082,444 TB patients in India, delays were analyzed and struck differences were observed between the public and private healthcare sectors. While the public sector had a higher proportion of cures at 35.8% than the private sector at 5.7%, both sectors had equivalent treatment success rates of about (85%). The dropout rates are concerning, with higher death rates in the public sector (4.5%) and higher loss to follow up rates in the private sector (3.4%). These results concurred with the need to enhance treatment adherence, follow-up mechanisms, and public–private integration to advance the treatment outcomes of TB care in India. The above findings stand in relation with Harsh D Shah et al., who concluded about gaps across the cascade of care as: diagnostic gaps and the interventions designed to close them (4).

Household contact (HHC) tracing data indicates critical gaps in follow-up processes, particularly in high-burden states like Uttar Pradesh, emphasizing the need for tuberculosis preventive treatment (TPT) to reduce transmission and progression among HHC. Mandar Pradkar et al.'s study highlighted important findings for national guidelines on screening and providing TPT for HHC of pulmonary TB (PTB) patients in India, which accounts for 27% of global TB cases. The study found that 68% of HHC diagnosed with active TB and 71% with latent TB infection were identified at baseline, indicating that PTB households are hotspots for TB transmission. The study supports WHO guidelines

to offer TPT to all HHC of PTB patients, given the high baseline risk of TB disease among them (13).

Addressing the gaps in TB care requires comprehensive strategies, including public awareness campaigns, improved diagnostic infrastructure, financial support, and coordination between public and private sectors. These interventions are crucial to achieving the goal of TB elimination by 2025. An essential framework for evaluating TB care quality is the care cascade, which assesses patient outcomes at various stages within the healthcare system. Despite recent progress in high-TB burden countries, gaps remain in understanding how to improve patient outcomes. This manuscript outlines a research program aimed at identifying why patients disengage from the healthcare system. It calls for new systematic reviews, observational cohort studies, intervention testing and development, and ongoing quality improvement programs integrated into national TB initiatives to generate necessary evidence for enhancing patient outcomes. There is a lack of high-quality research to address poor TB outcomes, particularly pretreatment loss to follow-up and post-treatment recurrence. Prioritizing research on interventions that meet patient needs, such as mental and nutritional support, is crucial. Specific groups, including men, those with a history of treatment, and individuals with drug-resistant TB, face significant challenges throughout their care. Funding an ambitious and innovative research program to close these gaps in the care cascade is necessary to improve patient outcomes and reduce disparities in TB care (15).

Summary data on household contact tracing denotes critical gaps in follow-up processes, particularly in high-burden states like Uttar Pradesh; hence, TPT stands to make a big difference in reducing transmission and progression among household contacts. The results of the Mandar Pradkar et al.'s study were instrumental in terms of national guidelines regarding screening and provisioning of TPT for household Contacts of PTB patients in India, which accounts for 27% of global cases of TB. In the baseline, 68% of HHC diagnosed with active TB and 71% with latent TB infection were identified, thus pointing out that PTB households are a hotspot for TB transmission. This study also justifies the WHO recommendation to offer TPT to all HHC of PTB patients amidst the high baseline risk of TB disease among them. Addressing these gaps in TB care will therefore call for multi-sectoral, comprehensive strategies from public awareness creation

to better diagnostic infrastructure and financial support, with intersectoral collaboration of the public and private sectors. In doing this, treatment interventions become one of the most important steps toward achieving the feat of a TB-free world by 2025. A care cascade framework is one logical means by which quality of TB care can be approached and appraised for patient outcomes at these different stages of the health system. Even with recent progress in high-TB-burden countries, gaps persist in understanding how to improve patient outcomes. This paper describes a research program as proposed that identifies the reasons patients disengage from the healthcare system. It will take ambitious and innovative investments into a research program to close gaps in the TB cascade of care in order to improve patient outcomes and decrease inequities in TB care.

The review of the care pathway for TB in India has brought out certain critical lacunae and deficiencies in the system, along with directed recommendations improving the outcome. Low testing for TB, covering only 68 percent of the cases, is marred by low levels of awareness, poor health-seeking behavior, and lack of access to diagnostics. Successful diagnosis stands at 57 percent, beset with problems like poor sample handling and delayed results. Only half of newly diagnosed cases of TB start treatment due to a lack of awareness, constraints in resources and poor intersectoral coordination. Low adherence to treatment at 43% is due to side effects of medication and a lack of support. Success rates after treatment are only 37% due to high rate of recurrence and poor follow-up care. These include public awareness raising campaigns, diagnostic infrastructure development, financial support to the patient, coordination among health-care sectors, and a comprehensive patient support system. All these attempts at improvement in the care rendered to the patients with tuberculosis will help in reducing the transmission, enhancing treatment outcome.

The National Strategic Plan for Tuberculosis Elimination 2017-2025 (NSP 2017-21) lays down the roadmap for India's efforts toward the elimination of TB, with a focus on patient-centered care, elimination of catastrophic costs, and prevention. Early diagnosis and universal drug susceptibility testing are simultaneously pursued with the establishment of patient support systems under the NSP, which is in line with goals outlined in the End TB Strategy. In fact, all these strategic plans are conceived to overcome systemic and socio-economic barriers that have thwarted so far all efforts at controlling TB, and also to ensure effectiveness and sustainability of interventions.(1).

The results of this study of TB control in India reflect complexity and call for comprehensive, multifaceted approaches.

The significant progress in notifications made for TB despite exogenous shocks as strong as the COVID-19 pandemic is underscored; at the same time, it exposes large diagnosis, treatment adherence, and financial protection gaps that will require targeted interventions, improved coordination between the public and private sectors, and robust mechanisms of financial support. By anchoring itself in national and global strategic plans and patient-centered care, India can bridge enormous distances toward this very objective: to eliminate TB by 2025.

CHAPTER 7

CONCLUSION

A closer look at TB in India underlines progress in the fight, but warns the battle is far from over.

The trend of TB prevalence has been oscillating from 2016 to 2022, and more importantly, the COVID-19 pandemic really messed up health care services. Notwithstanding this, India sent out the highest ever 2.42 million notifications for TB in 2022 alone. It is a pointer to the resilience of the health system in detection and reporting of cases. The differences in states' notification rates of tuberculosis, slating Delhi at the top and Kerala at the bottom, call for region-specific interventions toward improved TB detection and care.

This means the financial burden rests on the households affected by the TB, while catastrophic costs affected as high as 36% of families only in 2021. It, therefore, calls for an immediate extension of accesses to free services related to TB and enhanced financial protection, hence reducing the economic burden on the affected families. The diagnosis of TB is more complicated to deal with, coupled with other diseases like diabetes, tobacco use, and HIV. Integrated health services are therefore very important, considering that more than 2 million cases of TB were recorded among people living with HIV in 2022. Evidence points to delays in diagnosis and treatment on account of systemic and socio-economic barriers. Targeted interventions aimed at increasing public awareness, health system strengthening, and bridge-building between the public and private healthcare sectors could make a difference in how TB is treated.

Although the private health sector remains poorer in returns than the public health sector for the success rate of treatment for TB, the former reflects more dropouts from treatment as well. By carefully analyzing and taking note of the differences in the 2022 data in the management of TB between the public and private healthcare sectors, treatment adherence should be enhanced, and follow-up conditions strengthened. Integrating health care systems must be aligned to better outcomes in the treatment of TB. There are critical gaps in follow-up procedures of HHC care for pulmonary TB patients. In view of the facts that states like Uttar Pradesh top the list in terms of number of HHC, evidence alloy need of targeting interventions including TPT to reduce TB transmission and progression.

Large gaps in the care of HHC of pulmonary TB cases with bacteriological confirmation are present, particularly in the follow-up processes. States like Uttar Pradesh, having the highest number of HHC, point toward target-oriented interventions like TPT against transmission and progression of TB.

There is, therefore, no doubt that the elimination of the disease in India will surely happen by the agenda of 2025 if systemic barriers are removed recklessly, improvements made in financial protection to all eligible, and universal, comprehensive care. The continuous public awareness campaigns achievements made in diagnostic infrastructure and health service integration will sustain and accelerate progress.

CHAPTER 9

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