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GLOBAL BURDEN OF TUBERCULOSIS: PRESENT EPIDEMIOLOGICAL TRENDS, DETERMINANTS, AND FUTURE PROSPECTS FOR ELIMINATION IN INDIA

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ABSTRACT

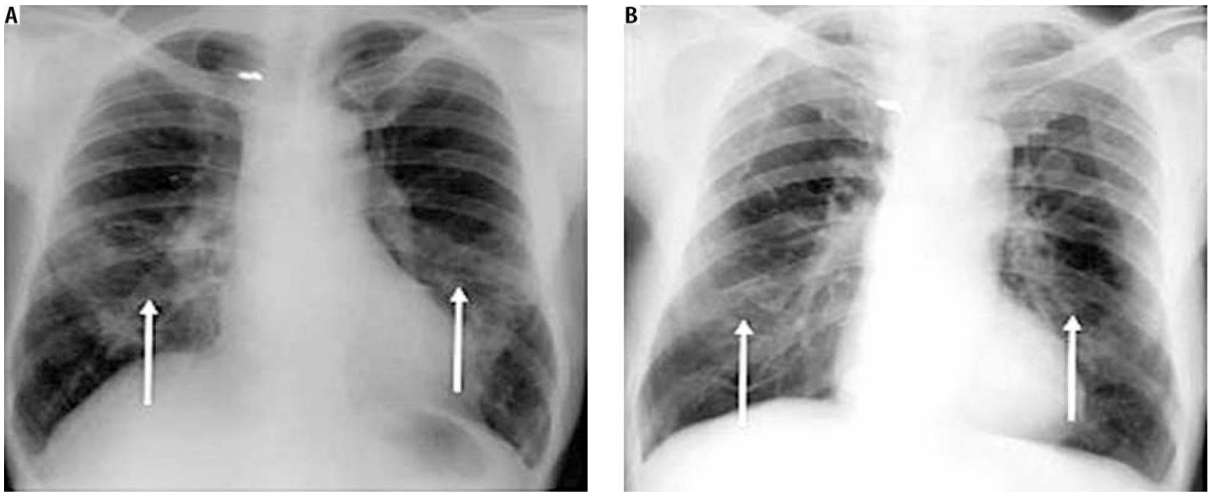
Tuberculosis continues to be one of the most difficult infectious diseases to deal with in the twenty-first century. India accounts for a disproportionately large share of the world's cases. Every year, millions of people die from tuberculosis, even though programming has been going on for decades. This is because structural, biological, social, and demographic factors all interact in complex ways. This review summarises the latest epidemiological data on the global and Indian tuberculosis burden, examines significant risk factors and comorbidities such as HIV, diabetes mellitus, drug resistance, and malnutrition, and evaluates the probability of eradicating tuberculosis in India by 2025 and 2035, in accordance with the World Health Organisation's (WHO) End TB Strategy. The review also discusses new problems that have emerged, such as multidrug-resistant TB (MDR-TB), how COVID-19 has affected TB services, and how new diagnostic and genetic techniques can help reduce TB.

KEYWORDS: Tuberculosis, MDR-TB, Rifampicin, COVID-19, DALYs, NTEP, XDR-TB, Diabetes Mellitus.

1. INTRODUCTION

Tuberculosis, caused by Mycobacterium tuberculosis, is the leading infectious agent-related cause of mortality globally.[1] The WHO Global Tuberculosis Report states that about 10 million people were diagnosed with TB in 2017.[2] Those 1.3 million died who were HIV-negative, and 300,000 died who were HIV-positive. Low- and middle-income countries (LMICs) are disproportionately afflicted by the disease, since their poverty, hunger, overcrowding, and inadequate health systems create optimal conditions for disease proliferation and transmission.[3]

India has a unique and important role in the global TB landscape. India is one of the 30 high-burden countries that the WHO has named, and it is responsible for a large part of the world's TB incidence, prevalence, and death.[4] The country's huge population, varied epidemiology, and the presence of both a large private healthcare sector and the public National Tuberculosis Elimination Programme (NTEP)[5] make it easier and harder to control TB. The World Health Assembly endorsed the WHO's End TB Strategy in May 2014. It set difficult goals, such as cutting TB incidence by 50% and TB deaths by 75% by 2025, and by 90% and 95%, respectively, by 2035. India has also vowed to eliminate TB by 2025, which is five years ahead of the global deadline. This makes the stakes even higher. This analysis provides a comprehensive overview of the principal determinants, epidemiological trends, and aspirations for future tuberculosis eradication in India, utilising global data to contextualise the Indian experience.



A. Initial Presentation **B. Follow-Up After Treatment**

Figure 1: Demonstrating Bilateral Lower Zone Infiltrates in Pulmonary Tuberculosis.

2. Global Epidemiological Overview

2.1 Mortality, Prevalence, and Incidence

TB is still a major problem worldwide. The Global Burden of Disease (GBD) Study 2016 reported 9.0 million new cases of TB-HIV co-infection. The WHO Global Tuberculosis Report 2017 said there were 6.3 million new TB cases among HIV-positive people in 2016, up from 6.1 million in 2015. These data show that tuberculosis is still a major problem around the world, even though people have been trying to manage it for decades.[1] In fig.2, the incidence rate of tuberculosis worldwide is shown.

There are just a few countries where the burden of illness is much higher than average. Eight countries account for two-thirds of the world's total, and six of those are in Asia.[6] Estimates suggest that 721,000 (uncertainty interval [UI] 473,000–1.35 million) young individuals developed tuberculosis in 2012, rendering the WHO South East Asian Region the area with the largest absolute number of tuberculosis cases.[7] Even if the number of people with tuberculosis is going down around the world, it is not going down fast enough to reach the End TB Strategy goals.[8] If the current downward trend continues, countries won't be able to reach the World Health Assembly's goals. This is especially true in places with a lot of HIV co-infection, drug resistance, and socioeconomic factors that make the situation worse.[3]

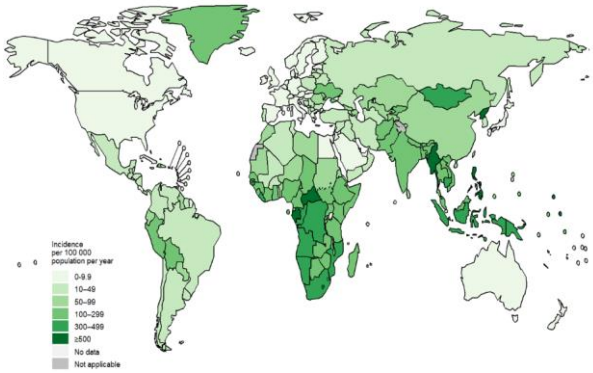


Figure 2: Global Incidence of Tuberculosis per 100,000 Population per Year.

2.2 Age and Sex Distribution

There is considerable variation in the global epidemiology of tuberculosis based on sex and age. Among low- and middle-income countries, the overall male-to-female (M: F) TB prevalence ratio for bacteriologically positive tuberculosis is 2.21. This means that TB has historically been more common among men. The M: F ratio varies widely by age: it is 1.28 for those aged 15–24 and 3.18 for those aged 45–54.[9] In places with a lot of HIV, the M: F

TB prevalence ratio is lower, and there are more women than men (0.67, 95% CI 0.49–0.90).[7] Young people are a group especially at risk. It is estimated that 1.78 million (UI 1.23–3.00 million) young people between the ages of 10 and 24 got TB in 2012, which is 17% of all new TB cases in the world.[7] Adolescence correlates with a notable increase in TB risk, consistent with earlier research from the pre-HIV period. In the Asia-Pacific region, the incidence of bacteriologically confirmed tuberculosis among youth ranges from 45 to 799 cases per 100,000, whereas in Africa it ranges from 160 to 462 cases per 100,000.[10]

Following infection, children under five years old are particularly susceptible to developing severe, disseminated forms of tuberculosis and the progression of the disease to an active state. Even though this group is more at risk, there is currently not enough high-quality regional and global data on the burden of tuberculosis in children. In 2000, there were almost 900,000 new cases of tuberculosis among children, accounting for about 11% of the total worldwide cases.[11]

2.3 Drug-Resistant Tuberculosis

Drug-resistant TB is one of the main threats to the global fight against tuberculosis. To treat MDR-TB, which require second-line drugs. Strains of tuberculosis that are resistant to at least isoniazid and rifampicin. These drugs are more expensive, harmful, and useless, and they take longer to work.[12] There were about 465,000 (95% CI 400,000–535,000) cases of MDR-TB in the world in 2019, and about 182,000 (95% CI 113,000–250,000) deaths.[13]

RR-TB, which stands for rifampicin-resistant TB, makes people very sick. In 2020, around 500,000 people developed RR-TB, which is expected to have caused 6.9 million (95% CI: 5.5–8.5 million) disability-adjusted life years (DALYs). The notable long-term health consequences of RR-TB beyond the acute phase are underscored by the statistic that 44% of these DALYs were experienced by TB survivors. The average burden of RR-TB was 17 (14–21) DALYs per person, which is 34% higher than that of rifampicin-susceptible TB.[14]

Southern African countries and former Soviet Union countries have the highest incidence of RR-TB per 100,000 inhabitants.[14] MDR-TB is most common in the former Soviet Union, China, and India. In many Eastern European countries, such as Kazakhstan and Ukraine, more than 50% of TB patients who have already been treated develop MDR-TB.[12]

XDR-TB and TDR-TB are even harder to treat than MDR-TB. The current success rates for XDR-TB treatment are about 40%, and for MDR-TB treatment, they are about 62%. New antibiotics such as bed aquiline and delamanid have shown promise in both efficacy and tolerability. However, local public health efforts are needed to keep them susceptible in the long run.[12]

3. TB Epidemiology in India

3.1 Burden and Trends

India has the most cases of tuberculosis in the world. The nation's tuberculosis epidemiology exhibits considerable diversity both epidemiologically and in terms of programmatic performance.[4] According to subnational TB prevalence surveys, subnational and district-level annual rate of TB infection surveys, and analysis of regularly gathered program surveillance data, there is a lot of local variation in the incidence, prevalence, rates of HIV co-infection, drug-resistant forms of TB, and use of TB services in the private sector. There are significant differences between urban and rural areas in epidemiology and programs.[5] Model forecasts could be affected by a lot of uncertainty about how many people in India have tuberculosis, how many people die from it, how many people have latent TB infection, and how much treatment is available in both the public and private sectors.[4] This lack of clarity shows how badly India needs to enhance its surveillance system and its ability to collect epidemiological data.

Mathematical modelling estimates suggest that making it easier for people in India to access high-quality care could reduce the number of TB cases by a median of 20% (range 5–41%) relative to baseline trends. However, activities intended solely to improve treatment for patients already receiving good care have little impact on baseline trends. This shows that India's biggest problem is not improving the standard of care for those who already receive it, but rather making it easier for more people to access it.[4]

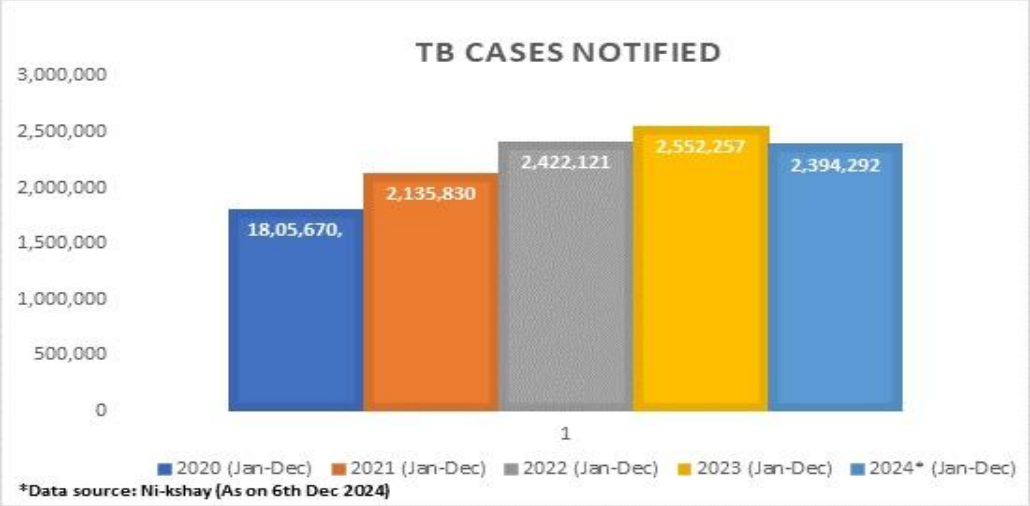


Figure 3: Trend of Tuberculosis Cases Notified in India (2020–2024, Jan–Dec).

3.2 Latent TB Infection and Preventive Treatment

India has a lot of LTBI. The next generation of tuberculosis sufferers is believed to be the 1.7 billion individuals worldwide who are latently infected with the illness.[5] Even though tuberculosis preventative treatment (TPT) is very important for accomplishing eradication goals, it is currently not a top priority in India.[15] The End TB Strategy's goal of reducing global TB incidence from over 1,250 cases per million to less than 100 cases per million in 20 years would not be possible without addressing the LTBI reservoir.[5]

One of the primary problems with implementing TPT in India is the need for locally driven solutions to address the changing and variable TB epidemiology, cost-effective and long-lasting interventions, and ongoing program monitoring and assessment. The epidemiology of TB in high-burden environments is influenced by ongoing transmission rather than the reactivation of imported cases; hence, lessons from low-incidence countries such as Australia, Europe, and North America may not be directly relevant to India.[5]

3.3 Drug-Resistant Tuberculosis in India

India is one of the countries with the most cases of MDR-TB in the world.[12] Some of the things that have led to the rise and spread of drug-resistant TB in India are poor treatment planning, low treatment adherence, a large private sector with inconsistent care quality, and the constant transmission of resistant strains.[4] So, making it easier for people to access high-quality care, such as testing for drug resistance and following standard treatment plans, is one of the main goals of India's TB elimination strategy.[12]

4. Key Determinants of TB Burden

4.1 HIV Co-infection

People living with HIV (PLHIV) are 21 to 34 times more likely to have tuberculosis (TB)[9], which makes HIV the biggest risk factor for getting the disease. M. and HIV. People with HIV are more likely to get M. because of a convoluted, two-way interaction between the two diseases. TB promotes the activation of this opportunistic disease. At the same time, TB infection speeds up the progression of AIDS.[16] TB was the leading cause of death among people living with HIV in 2019, accounting for around 270,000 deaths from HIV-associated TB and about one-third of deaths from AIDS. The HIV epidemic has changed the way tuberculosis spreads a lot. It used to be more frequent in men and at the ends of life, but now it is more common in women and younger people.[9] HIV infection accounts for 29% of tuberculosis-related fatalities in sub-Saharan Africa, a region where tuberculosis mortality has surged threefold over the last two decades. The growth in HIV prevalence has happened at the same time as an increase in TB notification rates, although with a delay of 4 to 7 years.[17] In fig.4, the data tells about the prevalence of HIV globally.

India has fewer TB patients with HIV than sub-Saharan Africa, but HIV co-infection is still a big problem for the country's TB burden. Integrated TB-HIV care is a vital component of the national response due to the markedly elevated risks of TB infection and adverse outcomes in PLHIV in India.[5]

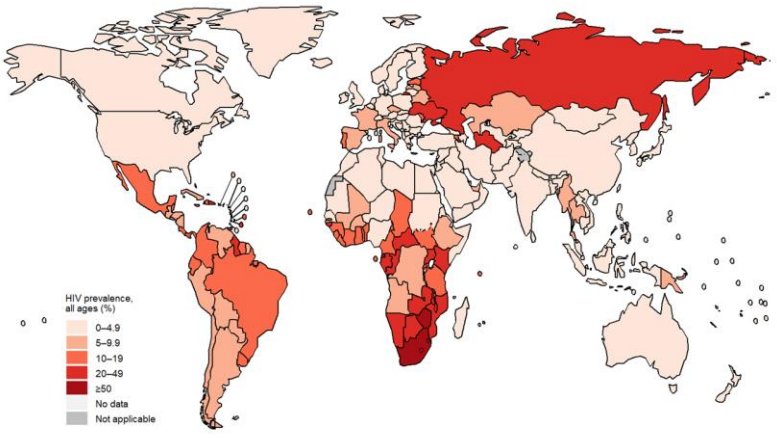


Figure 4: Global HIV Prevalence among Adults (%) – Country-wise Distribution.

4.2 Diabetes Mellitus

The simultaneous presence of diabetic mellitus and tuberculosis is a significant and growing public health issue. DM not only heightens the risk of TB treatment failure, relapse, and mortality, but also doubles or triples the likelihood of developing TB. In the next 20 years, it is expected that DM will become much more common around the world, especially in low- and middle-income countries (LMICs) with the most TB cases. Current estimates say that by 2035, more than 592 million people will have diabetes, most of them type 2 diabetes. Almost 80% of these cases would be in LMICs.[18]

In 22 countries that make up 80% of the world's TB burden, the percentage of TB cases connected to diabetes grew from 10% in 2010 to 15% in 2015. This number is expected to continue rising. Model simulations have assessed the impact of diabetes prevention on tuberculosis incidence; a reversal of the existing trend of decreasing TB incidence is anticipated if DM prevalence rises over the next two decades. In an alternative scenario, a 3% increase in global tuberculosis incidence beyond current levels would correlate with a projected 21% rise in diabetes prevalence worldwide by 2035. India is currently experiencing a significant diabetes epidemic, with one of the highest prevalence rates of diabetes globally. Because of this, the combination of the diabetes and tuberculosis epidemics in India makes it much harder to get rid of tuberculosis. This means that both diseases need to be screened for and treated simultaneously.[18]

4.3 Malnutrition and Socioeconomic Factors

Malnutrition is a known risk factor for TB since it lowers the immune system and makes people more likely to get M. TB and the progression to active illness. TB is a disease of poverty, and it hits LMICs and poor people the worst.[3] Socioeconomic factors like poverty, overcrowding, poor housing, and inadequate access to healthcare affect how tuberculosis spreads and how bad the disease is.[19]

It has been shown that the rate of TB cases declines faster in countries with better sanitation, lower child mortality, and higher human development indices.[2] One of the key reasons why India has so many cases of TB is that malnutrition is still quite high, especially among women and children. This means that action needs to be taken in many areas, not just health care.[5]

4.4 Alcohol Use, Tobacco Smoking, and Other Behavioural Risk Factors

Drinking alcohol and smoking are two behaviours that greatly increase the risk of getting TB. Alcohol usage, diabetes, and smoking were the main causes of TB deaths and DALYs in Nigeria. These results are in line with data from other places with a lot of TB, which shows how important it is to include behavioural risk factors in comprehensive TB management programs.[4] In Asian countries, HIV infection, diabetes, alcoholism, smoking, and malnutrition have all been associated with higher rates of TB morbidity and death. The incidence and mortality of tuberculosis have been associated with economic status, indicating that reduced treatment resistance correlates with a higher economic level.[6]

4.5 Cytomegalovirus Infection

A rising body of evidence suggests that cytomegalovirus infection may be a substantial and underrecognized risk factor for tuberculosis. A comprehensive review and meta-analysis indicated that individuals infected with CMV had a higher likelihood of developing TB compared to those uninfected. The number of TB episodes and CMV antibody levels were found to have a distinct dose-response relationship. CMV's impairment of systemic cytokine production and the responses of CD8+ T cells, γδ T cells, and macrophages is known to enhance the likelihood of initial TB infection or progression to TB illness. Both TB and CMV infections are more common in people with lower socioeconomic levels, which means that public health programs aimed at reducing poverty may be very important for lowering the number of cases of both diseases.[19]

4.6 Gender and Age-Specific Vulnerabilities

The feminisation of the TB pandemic in places with a high HIV incidence is an important epidemiological trend that has a big effect on how TB services are planned. In places where HIV is common, young women are more likely to get both HIV and TB.[8] Women with both TB and HIV have a 20% higher death rate than men with both diseases. A notable biological risk factor for tuberculosis in young women is the widespread use of injectable medroxyprogesterone acetate contraception, which exhibits estrogenic suppression and selective glucocorticoid effects.[9] Other behavioural factors that help close the gender gap in TB epidemiology are drinking alcohol and smoking tobacco. TB symptom screening misses 72% of cases of asymptomatic prevalent TB, and it is of little use in HIV-positive women, especially pregnant women.[10] These results underscore the imperative of tailoring TB

services to acknowledge that young women constitute a significant demographic impacted by the disease.

5. Surveillance, Data Quality, and Epidemiological Assessment

5.1 Challenges in TB Surveillance

An accurate estimate of the TB burden is needed to determine how many cases there are, how far along we are toward our elimination goals, and which policies to pursue. But in many countries with high TB rates, monitoring data is still incomplete or of poor quality.[18] For example, it was hard to combine data from one tuberculin survey and two national TB prevalence surveys in Bangladesh to figure out how many people now have TB. In most high-burden countries, there is even less information available, which makes it even harder to figure out how many people have TB.[19]

The most reliable way to determine how many people have TB is to monitor TB case notifications regularly. In places where everyone has health insurance, notifications are seen as a stand-in for actual occurrences, and people try to identify and quantify problems with the monitoring system. But in many LMICs, chronic underreporting and missed cases make notification data less reliable as a stand-in for real incidence.[20] Since 2009, 23 nations have conducted nationwide surveys of TB prevalence in their communities. This is a big step forward in getting credible data on the burden of tuberculosis. The Global Project on Anti-TB Drug Resistance Surveillance has been carefully collecting and studying data on drug resistance around the world since the middle of the 1990s.[20] These achievements have greatly improved the evidence foundation for TB control, but there are still major gaps, notably in sub-Saharan Africa and South Asia.

5.2 Age Disaggregation and Surveillance Gaps

A major problem with TB surveillance is that the data isn't broken down by age well enough, which makes it harder to figure out how many young people are getting sick.[9] Estimating the disease burden among young individuals is complicated by national TB programs frequently supplying the WHO with national surveillance data categorised into broad age groups (5–14, 15–24 years). The absence or inadequacy of age-specific data has resulted in the exclusion of numerous studies from systematic reviews. It is very important to improve the regular reporting of age in TB epidemiological research and to get good epidemiological data about TB in teens.[10]

5.3 Harnessing Data for Local Action

The End TB Strategy emphasises the importance of using data to guide local action. Tuberculosis epidemiological evaluations systematically describe and assess the surveillance methods established to monitor TB infections and fatalities. These studies encompass the gathering of data on TB determinants and the analysis and interpretation of temporal trends utilising national and subnational TB surveillance data.[17] Tools like the Screen TB tool can help you determine which groups are most likely to have TB and which methods should be used first. Mathematical modelling estimates facilitate the examination of the prospective impacts of current medicines on the tuberculosis burden.[18]

6. Genomic Approaches to TB Control

6.1 Whole-Genome Sequencing and Transmission Dynamics

Recent improvements in whole-genome sequencing (WGS) are transforming how genomics is used for TB epidemiology and diagnosis. WGS technologies have enabled more precise handling of the main concerns in transmission and monitoring, making it easier to control TB. WGS can detect transmission in homes and communities under population-based surveillance, irrespective of the TB burden in the context. As demonstrated in multiple TB epidemics, sequencing provides superior discriminatory capability compared to other genotyping methods for assessing strain-relatedness.[20]

WGS data can help identify potential "super-spreaders," those who may be responsible for too many secondary cases. It can also help with contact tracing. High-resolution genotyping can delineate transmission routes irrespective of treatment resistance, even in high-burden environments.[21] Combining genomic data with traditional epidemiological methods has been shown to improve the detection of ongoing TB transmission events.[23]

6.2 Genomics for Drug Resistance Surveillance

Genomic approaches are very helpful for monitoring the evolution of drug resistance. WGS can detect resistance mutations with a level of detail never before seen. This allows doctors to make more targeted treatment decisions and monitor resistance patterns.[21] In a retrospective observational study, WGS was more efficient than traditional genotyping methods for distinguishing relapse from reinfection in patients. This supports its utility in setting goals for treatment studies in high-burden contexts.[22]

6.3 Barriers to Implementation in India and Other LMICs

Genomic techniques could change the world, but there are significant problems with their use in the Global South, particularly in India. Some of these problems include a lack of bioinformatics tools, high sequencing costs, limited lab equipment, and challenges with data sharing and understanding. To address these problems, we will need to invest heavily in labs, training, and international collaboration.[21]

7. Mathematical Modelling and Projections for India

7.1 Feasibility of End TB Targets

By combining 11 mathematical models, the viability of China, India, and South Africa fulfilling the WHO global TB targets by 2025 was assessed. The data show that making it easier for people to get high-quality care cut the number of tuberculosis cases in India by a median of 20% (range 5–41%), which was below baseline trends.[4] This study underscores the imperative of enhancing access to high-quality tuberculosis diagnosis and treatment in India as the principal strategy for achieving eradication objectives.

7.2 Impact of Diabetes and Other Risk Factors on Projections

Model simulations indicate that the escalating diabetes epidemic may significantly hinder efforts to eliminate TB. If diabetes becomes more common over the next 20 years, the current trend of fewer tuberculosis cases will change. Planning for the country's TB eradication must take this interaction into account because it is especially concerning in India, where diabetes and TB are common.[18]

7.3 The Role of Preventive Treatment

Mathematical modelling has repeatedly shown that treating only active TB will not be sufficient to achieve the End TB Strategy targets for dramatic annual declines in incidence.[24] To decrease the global incidence of tuberculosis from over 1,250 cases per million to under 100 cases per million within 20 years, it is essential to expand testing and treatment for tuberculosis. This means that the next step in eliminating TB in India will require long-lasting, affordable treatments that target TB infection, new ideas, and solutions developed locally.[25]

8. Programmatic Challenges and Opportunities in India

8.1 The Public-Private Mix

One of the most interesting things about India's TB ecosystem is that it has both a large and diverse private healthcare industry and a public NTEP. In India, a significant portion of tuberculosis patients initially pursue treatment in the private sector, characterised by considerable variability in diagnostic and treatment criteria.[3] So, one of the most important programmatic issues is to get the private sector involved in drug susceptibility testing, standardised treatment, and TB notification.[4,5]

8.2 Health System Strengthening

To eliminate tuberculosis in India, the health system needs to improve. This means improved TB monitoring, more money, and prevention programs that focus on big risk factors like diabetes, smoking, and drinking.[22] The WHO Terminate TB Strategy outlines key areas to focus on to terminate the global TB pandemic and cut deaths from TB by 95% and new cases by 90% between 2015 and 2035.[23] Mathematical models like TIME Impact have been developed to help national TB programs and other TB officials better understand their own TB epidemic, plan their response, raise funds, and evaluate how well the response was implemented.[24] Technologies like these can help with the NTP programming cycle in India, which includes situational analysis, monitoring, and assessment.

8.3 Integrated Approaches to TB and Co-morbidities

Integrated approaches to tuberculosis control and co-morbidity management are essential, as HIV, diabetes, malnutrition, and other co-morbidities significantly influence the tuberculosis burden in India.[24] By screening TB patients for diabetic mellitus (DM), screening TB patients with DM for both active and latent TB, and improving access to DM therapy, the effects of DM on TB may be lessened. To minimise TB deaths in this high-risk group, we also need to give them antiretroviral treatment for TB, which is part of integrated TB-HIV treatments.[25]

8.4 Impact of COVID-19 on TB Services

The COVID-19 pandemic has hurt TB services throughout the world, but mainly in India. The number of missed TB cases has gone up a lot because of the pandemic's effects on TB diagnosis, treatment, and contact tracing.[24] Finding the millions of TB patients who were overlooked in 2020 and beyond should be the primary objective of national TB programs. In fig. 5, a comparative analysis of TB vs. COVID-19 cases is shown. Health systems in areas

with a lot of disease have a big problem with COVID-19, TB, and HIV all at once. This means that treatments need to be coordinated and integrated.

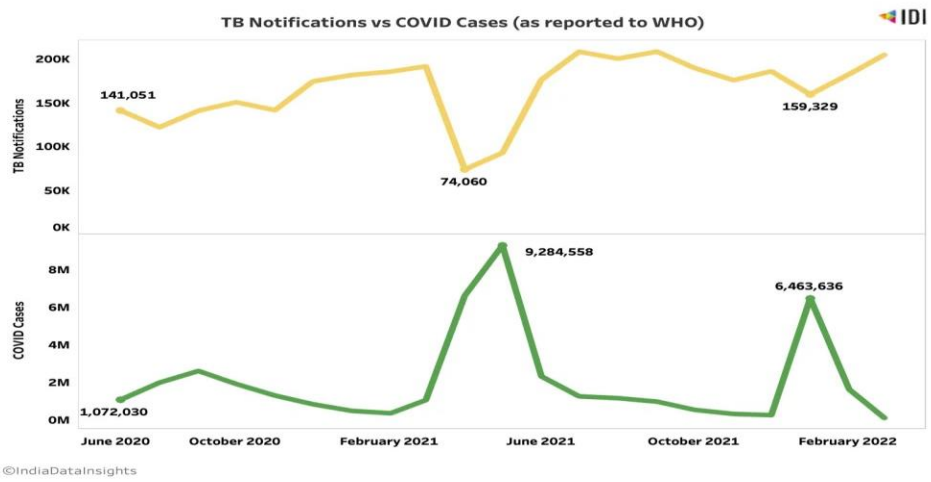


Figure 5: Impact of COVID-19 on TB Notifications: Comparative Trend Analysis (2020–2022)

9. Future Prospects toward TB Elimination in India

9.1 The End TB Strategy and India's 2025 Target

The World Health Assembly endorsed the End TB Strategy in May 2014 to end the global TB epidemic by 2035. The strategy calls for a 90% drop in TB cases, a 95% drop in TB deaths, and no catastrophic expenses for households impacted by TB.[25] India's political commitment to ending the epidemic is demonstrated by its goal to eliminate TB by 2025, five years ahead of the global target.[26] In fig. 6, the comparison of new TB cases vs. mortality is shown.

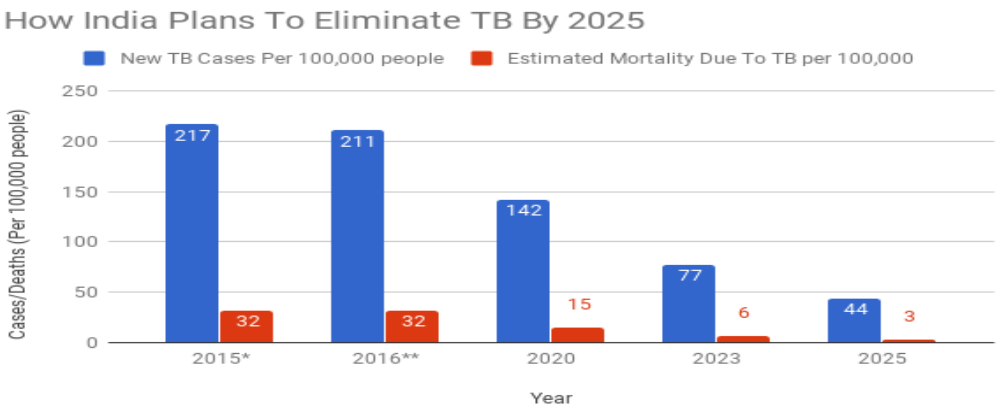


Figure 6: India's Roadmap to TB Elimination by 2025: Trends in Incidence and Mortality (per 100,000 Population).

To reach these goals, we will need to use many different methods, such as investing more money, strengthening the health system, improving TB monitoring, and implementing programs to reduce major risk factors like diabetes, smoking, and drinking.[19] For new tools and strategies to be made and used, national health authorities, non-governmental organisations, the research community, the diagnostic and pharmaceutical industries, and local, national, and international partners-both public and private-will need to work closely together.[20]

9.2 New Diagnostics and Vaccines

To get closer to eliminating tuberculosis, we need to improve diagnosis, treatment, and immunisation. Finding better TB vaccines that offer stronger, longer-lasting protection against active TB remains a primary research goal. WGS and other genomic technologies have the potential to change the way we monitor medication resistance, investigate epidemics, and track TB. As costs decline and lab capacity increases, these tools could become important components of TB control efforts in India and other areas with high case volumes.[21,22]

9.3 Addressing Social Determinants

To get rid of tuberculosis in India, we need to deal with the societal factors that cause it, like poverty, malnutrition, overcrowding, and not being able to get medical care. Public health programs that focus on social protection and poverty reduction may be very effective in reducing the global burden of tuberculosis.[19] India may lead the world by conducting operational research and implementing measures to reduce the number of tuberculosis cases.[25]

9.4 Surveillance System Strengthening

Enhanced surveillance is a primary focus of tuberculosis control research. Epidemiological surveys are essential for evaluating progress towards eradication targets, especially in high-burden countries. TB prevalence surveys are feasible even in resource-limited settings because the expected costs in these countries are less than 1% of the overall cost of the TB control program. To keep an eye on India's progress toward eliminating TB, surveillance methods would need to keep improving, for example, by breaking down data by age and using genomic surveillance more often.[28]

10. CONCLUSION

India is disproportionately impacted by tuberculosis, which remains a significant global public health issue. The epidemiology of tuberculosis in India is influenced by a complex interplay of biological, social, demographic, and programmatic factors, including HIV co-infection, diabetes mellitus, malnutrition, treatment resistance, and the substantial private healthcare sector. To reach India's lofty aim of getting rid of TB by 2025, a comprehensive, multisectoral strategy that addresses the immediate and underlying causes of the TB burden is needed. Some of the most important things to do are to improve TB surveillance systems, make it easier for people to get high-quality TB diagnosis and treatment, give more people preventive treatment for TB, combine TB control with managing other diseases like HIV and diabetes, involve the private sector, and address the social causes of TB through social protection and poverty reduction. Genetic surveillance and mathematical modelling are two new methods that can help make policy and resource allocation decisions based on facts. India can lead the way in eliminating TB worldwide and help reach the larger goal of eliminating the TB pandemic by 2035 if political will, more funding, and strong cooperation between domestic and international partners persist.

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CONFLICT OF INTEREST: None.

Abbrevations

TB - Tuberculosis

DM – Diabetes Mellitus

MDR-TB – Multi drug resistant tuberculosis

GBD – Global Burden of Disease

UI - Uncertainty Interval

NTEP - National Tuberculosis Elimination Programme

HIV – Human Immune Deficiency Virus

DALYs - Disability-Adjusted Life Years

XDR-TB - Extensively Drug-Resistant Tuberculosis.

AIDS – Acquired Immune Deficiency Syndrome

CMV – Cytomegalic virus

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