The growing challenge of drug resistance in tuberculosis: Insights from India

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Abstract:
Drug-resistant tuberculosis (TB) remains a significant public health concern in India, posing formidable challenges to disease control efforts. This abstract reviews the current landscape of drug-resistant TB in India, highlighting the prevalence, patterns, and contributing factors. It discusses the importance of early detection and appropriate management strategies in curbing the spread of drug-resistant TB strains. The abstract emphasizes the need for comprehensive interventions, including strengthened surveillance, improved diagnostic capabilities, and enhanced treatment regimens. It underscores the role of socioeconomic factors, healthcare infrastructure, and patient adherence in shaping the trajectory of drug-resistant TB in India. Furthermore, the abstract emphasizes the importance of collaborative efforts among stakeholders, including government agencies, healthcare providers, and civil society, in addressing this complex issue. Future directions for research and interventions to mitigate the burden of drug-resistant TB in India are also discussed. Multidrug-resistant TB (MDR-TB) persists as a pressing public health crisis, with treatment accessibility remaining a challenge, as only a fraction of affected individuals received proper care. Nonetheless, global efforts have yielded substantial progress, saving an estimated 75 million lives since 2000. However, sustained commitment and financial investment are imperative, with an annual necessary of US$ 13 billion for extensive TB prevention, diagnosis, treatment, and care. The United Nations Sustainable Development Goals (SDGs) include the ambitious target of ending the TB epidemic by 2030, underscoring the urgency of concerted action to combat this persistent threat to public health and global development.
Key words: Drug Resistance, Tuberculosis, TB epidemic, Multidrug-resistant.

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I.   Introduction

A total of 1.3 million people died from TB in 2022 (including 167 000 people with HIV). Worldwide, TB is the second leading infectious killer after COVID-19 (above HIV and AIDS).In 2022, an estimated 10.6 million people fell ill with tuberculosis (TB) worldwide, including 5.8 million men, 3.5 million women and 1.3 million children. TB is present in all countries and age groups. TB is curable and preventable. Multidrug-resistant TB (MDR-TB) remains a public health crisis and a health security threat. Only about 2 in 5 people with drug resistant TB accessed treatment in 2022.

Global efforts to combat TB have saved an estimated 75 million lives since the year 2000. US$ 13 billion is needed annually for TB prevention, diagnosis, treatment and care to achieve the global target agreed at the 2018 UN high level-meeting on TB. Tuberculosis has claimed its victims throughout much of known human history. It reached epidemic proportions in Europe and North America[1] during the 18th and 19th centuries, earning the sobriquet, "Captain Among these Men of Death." Then it began to decline. A TB contact investigation[2] is a TB control strategy used to identify, find, and assess TB contacts and provide appropriate treatment for latent TB infection (LTBI) or TB disease, if needed. Effective contact investigations interrupt the spread of TB in communities and help prevent outbreaks of TB.

Ending the TB epidemic by 2030 is among the health targets of the United Nations Sustainable Development Goals (SDGs). Tuberculosis (TB) is an infectious disease that most often affects the lungs and is caused by a type of bacteria. It spreads through the air when infected people cough, sneeze or spit. Tuberculosis is preventable and curable. About a quarter of the global population is estimated to have been infected with TB bacteria. About 5–10 % of people infected with TB will eventually get symptoms and develop TB disease. Those who are infected but not (yet) ill with the disease cannot transmit it. TB disease is usually treated with antibiotics and can be fatal without treatment. In certain countries, the Bacille Calmette-Guérin (BCG) vaccine is given to babies or small children to prevent TB. The vaccine prevents TB outside of the lungs but not in the lungs.Fig.1 shows Estimated number of incident TB cases in 2022, for countries with at least 100000 incident

cases.Fig. 2 shows the updateed WHO estimates of the number of deaths caused by TB in India, 2000-2022. There are several technical challenges[3] related to: (i) early case detection and effective treat- ment of both drug-susceptible and -resistant TB; (ii) prevention of drug-resistant TB; (iii) control and management of risk factors, such as human immu- nodeficiency virus (HIV) infection, diabetes and smoking
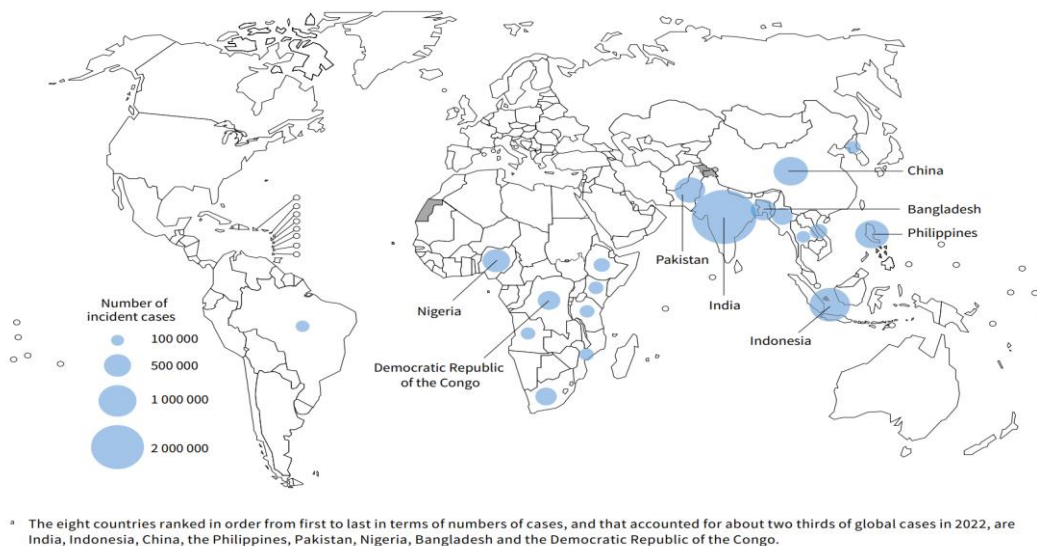

Figure 1: Estimated number of incident TB cases in 2022, for countries with at least 100000 incident cases.
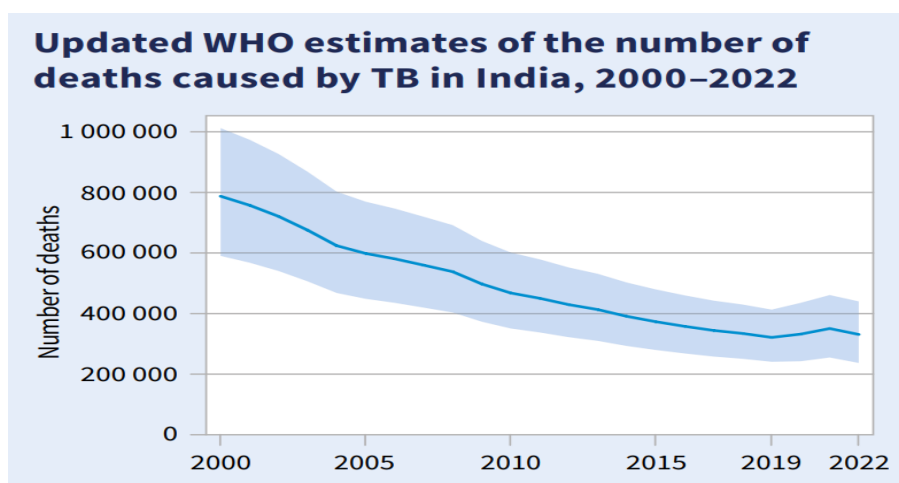

Figure 2: Updateed WHO estimates of the number of deaths caused by TB in India, 2000-2022.

I. India TB Report 2024

1. The India TB report 2024:

The India TB Report 2024, released by the Ministry of Health and Family Welfare, presents significant findings regarding the trends in Tuberculosis (TB) cases and mortality. The report highlights a commendable decline in the TB mortality rate, which has decreased from 28 per lakh population in 2015 to 23 per lakh population in 2022. This progress reflects the ongoing efforts to combat the disease. Despite this improvement, the majority of TB cases continue to be reported by government health centres. However, there has been a notable uptick in notifications from the private sector, indicating a positive trend in the engagement of private healthcare providers in TB management. In 2023, approximately 33% or 8.4 lakh of the 25.5 lakh TB cases were reported by the private sector, a significant increase compared to the 1.9 lakh cases reported by the private sector in 2015. This rise underscores the expanding role of private healthcare in TB notification and treatment. Additionally, the report notes a slight increase in the estimated incidence of TB, with 27.8 lakh cases in 2023 compared to the previous year's estimate of 27.4 lakh. Despite this increase, the mortality due to TB remained stable at 3.2 lakh

in 2023, indicating a sustained effort in controlling TB-related deaths. Moreover, India has made substantial progress in reducing overall TB mortality, with the number of deaths dropping from 4.94 lakh in 2021 to 3.31 lakh in 2022. This reduction is a significant achievement in the national TB control program[10-12]. Furthermore, India successfully reached its 2023 target by initiating treatment in 95% of patients diagnosed with TB, demonstrating the country's commitment to ensuring that diagnosed patients receive timely and appropriate treatment. These efforts are crucial in the ongoing battle against TB and reflect the country's dedication to ultimately eliminating the disease. The report provides a comprehensive overview of the current TB situation in India and highlights the progress made as well as the challenges that remain. It underscores the importance of continued collaboration between public and private sectors and the need for sustained efforts to maintain and further the gains achieved in TB control and prevention. TB cases in India over the years are represented in the Table 1.

Table 1: TB cases in India over the years

TB CASES IN INDIA OVER THE YEARS

	India TB Report 2020	2023	2024
Estimated TB cases	26.9 lakh	27.4 lakh	27.8 lakh
Number of cases reported	24.04 lakh	24.2 lakh	25.5 lakh
Reporting from private sector	6.8 lakh	7.3 lakh	8.4 lakh
% cases from private sector	28.20%	30%	32.90%
Estimated mortality	4.36 lakh	3.2 lakh	3.2 lakh

2. Multifaceted Challenges in India's Fight Against Tuberculosis

Despite setting ambitious goals to eliminate tuberculosis (TB) by 2025, India has faced significant challenges in meeting these targets. In 2023, the number of recorded TB cases and deaths fell short of the country's expectations. Various risk factors contribute to the incidence and treatment outcomes of TB, including undernourishment, HIV, diabetes, alcohol use, and smoking. In 2022, nearly 7.44 lakh TB patients were undernourished. To address this, the government provides monthly nutritional support of Rs 500 to nearly one crore beneficiaries, and the Ni-kshay Mitra programme encourages the donation of food baskets. People living with HIV are 20 times more likely to develop TB symptoms compared to the general population, with 94,000 TB patients also having HIV in 2022. Diabetes significantly escalates the likelihood of contracting TB, with 1.02 lakh of the 3.70 lakh global TB patients with diabetes residing in India. Diabetics face a two-to-threefold increased risk of contracting TB, which is associated with a higher chance of developing Multi-Drug Resistant TB, and TB treatment is less effective in diabetics. In 2023, 92% of TB patients were screened for diabetes, with 7.7% being diagnosed, and 63% of those diagnosed began diabetes treatment. Alcohol use also raises the risk of TB infection, with a daily intake of more than 50 ml linked to a higher risk of TB infection and recurrence. Of the 18.8 lakh TB patients screened for alcohol use, 7.1% were identified as users. Similarly, 19.1 lakh TB patients were screened for tobacco use, with 11% identified as users and 32% of these linked to tobacco cessation services. These multifaceted challenges underscore the complexity of addressing TB in India

3. Symptoms
People with latent TB infection don't feel sick and aren't contagious. Only a small proportion of people who get infected with TB will get TB disease and symptoms. Babies and children are at higher risk.
Certain conditions can increase a person's risk for tuberculosis disease:
diabetes (high blood sugar)
weakened immune system (for example, HIV or AIDS)
being malnourished
tobacco use.
Unlike TB infection, when a person gets TB disease, they will have symptoms. These may be mild for many months, so it is easy to spread TB to others without knowing it. Common symptoms of tuberculosis (TB) include a prolonged cough, which may sometimes be accompanied by blood, chest pain, weakness, fatigue, weight loss, fever, and night sweats. The specific symptoms experienced can vary depending on the area of the body where TB becomes active. While TB most commonly affects the lungs, it can also target other parts of the body such as the kidneys, brain, spine, and skin.

4. Diagnosis[8]

WHO recommends the use of rapid molecular diagnostic tests as the initial diagnostic test in all persons with signs and symptoms of TB.

Rapid diagnostic tests recommended by WHO include the Xpert MTB/RIF Ultra and Truenat assays. These tests have high diagnostic accuracy and will lead to major improvements in the early detection of TB and drug-resistant TB. A tuberculin skin test (TST) or interferongamma release assay (IGRA) can be used to identity people with infection.

Diagnosing multidrug-resistant and other resistant forms of TB (see multidrug-resistant TB section below) as well as HIV-associated TB can be complex and expensive.

Tuberculosis is particularly difficult to diagnose in children.

5. Standard Treatment

Antibiotics Used. The standard treatment for TB involves a combination of antibiotics taken over a period of several months. The most commonly used antibiotics are:

Isoniazid, Rifampin,Pyrazinamide,Ethambutol,Streptomycin.

Treatment Regimen

Duration: Typically, TB treatment lasts between 4 to 6 months.

Consistency: It is critical to take these medications daily as prescribed.

Importance of Adherence

Continuous Treatment: The antibiotics must be taken continuously without interruption. Stopping the treatment early or skipping doses can be dangerous.

Drug Resistance: If the medications are not taken properly, some TB bacteria may survive. These surviving bacteria can become resistant to the standard drugs, making the disease much harder to treat.

Drug-Resistant TB

Definition: Tuberculosis that does not respond to the standard set of antibiotics (isoniazid, rifampin, pyrazinamide, ethambutol, streptomycin) is known as drug-resistant TB.

Treatment Challenges: Treating drug-resistant TB is more complicated and involves more toxic and expensive medications. The treatment period is also longer, often extending beyond the standard 4-6 months.

Key Points

Early Diagnosis: Early diagnosis and proper treatment are crucial to prevent the spread of TB and the development of drug-resistant strains.

Medical Supervision: Always follow the treatment plan under the supervision of a healthcare provider.

Public Health Implications: Adhering to the treatment not only ensures personal recovery but also helps in controlling the spread of TB in the community. In summary, the effective treatment of TB relies on a strict regimen of antibiotics taken consistently over several months. Deviating from this regimen can lead to drug resistance, which complicates treatment and poses a greater public health risk.Prevention

To help prevent tuberculosis (TB) infection and its spread, follow these steps:

Seek medical attention promptly if you experience symptoms such as a prolonged cough, fever, or unexplained weight loss. Early treatment for TB can help stop the disease from spreading and improve your chances of recovery.

Get tested for TB infection if you are at increased risk, such as having HIV or being in close contact with individuals who have TB in your household or workplace.

Complete the full course of prescribed treatment to prevent TB if your doctor recommends it.

Practice good hygiene if you have TB, including avoiding contact with others, wearing a mask, covering your mouth and nose when coughing or sneezing, and properly disposing of sputum and used tissues. Implement special measures like using respirators and ensuring proper ventilation in healthcare and other institutions to reduce the risk of infection. The pooled prevalence of bacteriologically positive pulmonary tuberculosis[6] was 295.9 (95% confidence interval: 201.1–390.6) per 100,000 population. The prevalence was higher among males than females and in rural areas compared to urban areas.

6. Multidrug-resistant TB

Drug resistance emerges when TB medicines are used inappropriately, through incorrect prescription by health care providers, poor quality drugs, or patients stopping treatment prematurely.

Multidrug-resistant tuberculosis (MDR-TB)[5] is a form of TB caused by bacteria that do not respond to isoniazid and rifampicin, the 2 most effective first-line TB drugs. MDR-TB is treatable and curable by using second-line drugs. However, second-line treatment options require extensive medicines that are expensive and toxic.MDR-TB is treatable and curable by using second-line drugs such as bedaquiline. Delamanid is a newer drug that is

used in the treatment of multidrug-resistant TB (MDR-TB) and is often used in combination with other drugs. In some cases, more extensive drug resistance can develop. TB caused by bacteria that do not respond to the most effective second-line TB drugs can leave patients with very limited treatment options. MDR-TB remains a public health crisis and a health security threat. Only about 2 in 5 people with drug resistant TB accessed treatment in 2022.

In accordance with WHO guidelines, detection of MDR/RR-TB requires bacteriological confirmation of TB and testing for drug resistance using rapid molecular tests or culture methods. In 2022, new WHO guidelines prioritize a 6-month regimen – the BPaLM/BPaL – as a treatment of choice for eligible patients. The shorter duration, lower pill burden and high efficacy of this novel regimen can help ease the burden on health systems and save precious resources to further expand the diagnostic and treatment coverage for all individuals in need. In the past, MDR-TB treatment used to last for at least 9 months and up to 20 months. WHO recommends expanded access to all-oral regimens.

Tuberculosis (TB) treatment has significantly advanced since the development of effective drug therapies in the 1940s. The World Health Organization (WHO) has established comprehensive guidelines for the treatment of TB, emphasizing regimens tailored to the type of TB infection and patient demographics. First-line agents[4] for treatment of TB disease consist of isoniazid, a rifamycin (rifampin or [less frequently] either rifapentine or rifabutin), pyrazinamide, and ethambutol; in addition, moxifloxacin is a first-line agent when administered in combination with isoniazid, rifapentine, and pyrazinamide

Drug-Susceptible TB

For individuals with drug-susceptible TB, including both pulmonary and extrapulmonary forms, the latest WHO guidelines recommend a 6-month regimen comprising:

Initial Phase (First 2 months): Isoniazid (H), Rifampicin (R), Ethambutol (E), and Pyrazinamide (Z).
Continuation Phase (Next 4 months): Isoniazid (H) and Rifampicin (R).
An alternative 4-month regimen for people aged 12 years and older with drug-susceptible pulmonary TB includes:

Rifapentine (P), Isoniazid (H), Pyrazinamide (Z), and Moxifloxacin (M).
For children and adolescents (ages 3 months to 16 years) with non-severe TB and no resistance to Rifampicin (R) and Isoniazid (H):

Initial Phase (First 2 months): Isoniazid (H), Rifampicin (R), Pyrazinamide (Z), and sometimes Ethambutol (E).
Continuation Phase (Next 2 months): Isoniazid (H) and Rifampicin (R).

Drug-Resistant TB

The treatment for drug-resistant TB, including rifampicin-resistant TB (RR-TB) and multidrug-resistant TB (MDR-TB, resistant to both Isoniazid and Rifampicin), involves more complex regimens. The latest WHO guidelines prioritize a new 6-month regimen known as BPaLM, which includes:

Bedaquiline (B)
Pretomanid (Pa)
Linezolid (L)
Moxifloxacin (M)
For pre-extensively drug-resistant TB (pre-XDR-TB, resistant to Rifampicin and any fluoroquinolone), the regimen can be adjusted to BPaL (excluding Moxifloxacin). This regimen is recommended for individuals aged 14 years and older, based on safety data. For those ineligible for the 6-month regimen, longer regimens of 9 months or more are available.

Treatment Success Rates

The success rate for the 6-month regimen for drug-susceptible TB is reported at least 85% by WHO's 194 Member States. For RR-TB, national treatment success rates vary between 50-75%, with a global average recently improving to 63%. The BPaLM regimen has shown a clinical trial success rate of 89%.

Preventive treatment options for TB infection include:

Weekly dose of Isoniazid (H) and Rifapentine (P) for 3 months (3HP)
Daily dose of Isoniazid (H) and Rifampicin (R) for 3 months (3HR)
Daily dose of Isoniazid (H) and Rifapentine (P) for 1 month (1HP)
Daily dose of Rifampicin (R) for 4 months (4R)
Daily dose of Isoniazid (H) for 6 months (6H) or longer

Vaccination

Bacillus Calmette-Guérin (BCG) is the live attenuated vaccine form of Mycobacterium bovis used to prevent tuberculosis and other mycobacterial infections. The vaccine was developed by Calmette and Guérin and was first administered to human beings in 1921. BCG is the only vaccine[9] against tuberculosis. It is primarily effective in preventing severe forms of TB in children. Currently, there is no licensed vaccine that effectively prevents TB disease in adults. However, the M72/AS01E candidate vaccine has shown promising results in Phase II trials. Advancements in TB treatment and prevention have significantly improved patient outcomes. Continued research and adherence to WHO guidelines are essential for combating TB effectively.

7. TB and HIV

People living with HIV are 16 (uncertainty interval 14–18) times more likely to fall ill with TB disease than people without HIV. TB is the leading cause of death among people with HIV. HIV and TB form a lethal combination, each speeding the other's progress. Without proper treatment, 60% of HIV-negative people with TB on average and nearly all HIV-positive people with TB will die. In 2022, about 167 000 people died of HIV-associated TB. The percentage of notified TB patients who had a documented HIV test result in 2022 was 80%, up from 76% in 2021. The WHO African Region has the highest burden of HIV-associated TB. Overall in 2022, only 54% of TB patients known to be living with HIV were on antiretroviral therapy (ART). WHO recommends a 12-component approach of collaborative TB-HIV activities, including actions for prevention and treatment of infection and disease, to reduce deaths.

II. Impact

Tuberculosis mostly affects adults in their most productive years. However, all age groups are at risk. Over 80 % of cases and deaths are in low- and middle-income countries. TB occurs in every part of the world. In 2022, the largest number of new TB cases occurred end TB Strategy: Adopted in 2014, this strategy aims to end the TB epidemic by driving down TB deaths and incidence while eliminating catastrophic costs associated with TB. The strategy outlines global impact targets to reduce TB deaths by 90% and new cases by 80% between 2015 and 2030.Overview The WHO Global Tuberculosis Report[7] provides a comprehensive and up-to-date assessment of the TB epidemic and of progress in prevention, diagnosis and treatment of the disease, at global, regional and country levels. This is done in the context of global TB commitments, strategies and targets.

UN High-Level Meeting on TB: Held on September 22, 2023, this meeting elevated discussions about ending the TB epidemic to the level of heads of state and government. The resulting political declaration reaffirmed existing commitments and introduced new ones for the period 2023–2027. TB Statistics: In 2022, an estimated 10.6 million people fell ill with TB worldwide, resulting in 1.3 million deaths. TB is present in all countries and age groups but is curable and preventable. World TB Day 2024: The theme, "Yes! We can end TB!", conveys a message of hope and emphasizes the need for high-level leadership, increased investments, and faster uptake of new WHO recommendations.

Call for Action: WHO calls for action on several fronts to ensure commitments made to end TB are achieved, including high-level leadership, sustainable investment of resources, scaling up access to TB preventive treatment and screening services, multisectoral action, and tackling health inequities. Dr. Kasaeva emphasizes the importance of joint actions to drive the TB response, save lives, and achieve global TB targets. WHO will continue to provide global leadership for the TB response in collaboration with stakeholders. Advocacy and Communications Package: WHO has developed an advocacy and communications package to support awareness building and drive action on World TB Day. These points highlight the urgency of addressing TB through coordinated efforts, leadership, investment, and multisectoral action to save lives and achieve global TB targets. WHO's South-East Asian Region (46%), followed by the African Region (23%) and the Western Pacific (18%). Around 87% of new TB cases occurred in the 30 high burden countries, with more than two-thirds of the global total in Bangladesh, China, Democratic Republic of the Congo, India, Indonesia, Nigeria, Pakistan and the Philippines. Globally, about 50% of TB patients and their households face total costs (direct medical expenditures, non-medical expenditures and indirect costs such as income losses) that are catastrophic (>20% of total household income), far from the WHO End TB Strategy target of zero. Those with compromised immune systems, such as people living with HIV, under nutrition or diabetes, or people who use tobacco, have a higher risk of falling ill. Globally in 2022, there were 2.2 million new TB cases that were attributable to under nutrition, 0.89 million to HIV infection, 0.73 million to alcohol use disorders, 0.70 million to smoking and 0.37 million to diabetes. Investments to end TB US$ 13 billion are needed annually for TB prevention, diagnosis, treatment and care to achieve global targets agreed on at the UN high level-TB meeting.

As in the past decade, most of the spending on TB services in 2022 (80%) was from domestic sources. In low- and middle-income countries, international donor funding remains crucial. The main source is the Global Fund to Fight AIDS, Tuberculosis and Malaria (the Global Fund). The United States Government is the largest contributor of funding to the Global Fund and also the largest bilateral donor. For research and development, according to the Treatment Action Group, only US$ 1 billion were available in 2022 of the US$ 2 billion required per year to accelerate the development of new tools. At least an extra US$ 1 billion per year is needed to accelerate the development of new tools.

WHO is working closely with countries, partners and civil society in scaling up the TB response. Six core functions are being pursued by WHO to contribute to achieving the targets of the UN high-level meeting political declaration, Sustainable Development Goals, End TB Strategy and WHO strategic priorities: providing global leadership to end TB through strategy development, political and multisectoral engagement, strengthening review and accountability, advocacy, and partnerships, including with civil society. Shaping the TB research and innovation agenda and stimulating the generation, translation and dissemination of knowledge; setting norms and standards on TB prevention and care and promoting and facilitating their implementation;developing and promoting ethical and evidence-based policy options for TB prevention and care; ensuring the provision of specialized technical support to Member States and partners jointly with WHO regional and country offices, catalysing change, and building sustainable capacity; and monitoring and reporting on the status of the TB epidemic and progress in financing and implementation of the response at global, regional and country levels.Fig.3 shows the WHO end TB strategy: 2025 milestones and 2018 UN high-level meeting on TB: teratment targets.
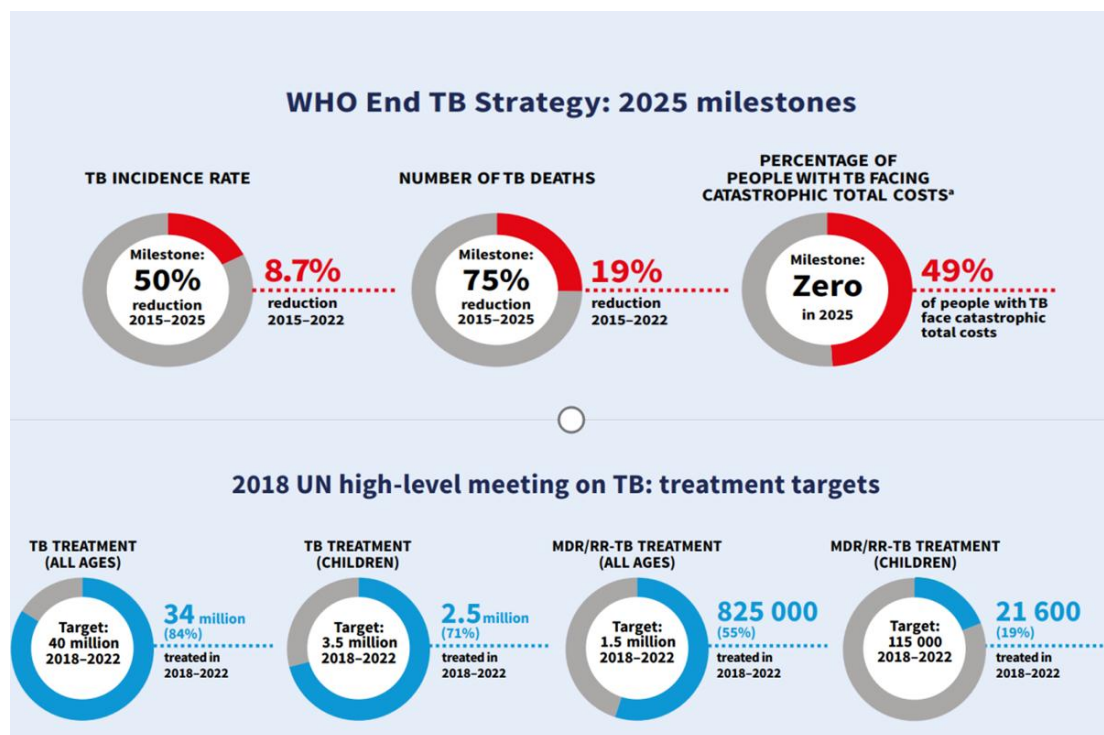

Figure 3: Who end TB strategy: 2025 milestones and 2018 UN high-level meeting on TB: treatment targets.

III. Global and India initiatives

Global initiatives to combat tuberculosis (TB) encompass a variety of strategies and partnerships. The World Health Organization (WHO) has launched the "Find. Treat. All. EndTB" initiative in collaboration with the Global Fund and the Stop TB Partnership, aiming to identify and treat all TB patients effectively. Additionally, WHO publishes the Global Tuberculosis Report to monitor progress and challenges in the fight against TB worldwide. The Global Plan to End TB, 2023-2030, provides a detailed roadmap for ending TB as a public health issue by 2030, outlining necessary actions and financial resources. This goal, embraced by all United Nations (UN) Member States and WHO, aligns with the End TB Strategy, which significantly broadens the efforts under the UN's Sustainable Development Goal 3.3 to eliminate TB. India has implemented several national initiatives to eradicate TB, reflecting its commitment to the global fight against the disease. The Pradhan Mantri TB Mukt Bharat Abhiyan and the National Strategic Plan (NSP) for Tuberculosis Elimination

(2017-2025) are cornerstone programs aimed at reducing TB prevalence. The TB Harega Desh Jeetega campaign and the Nikshay Poshan Yojna focus on increasing awareness and providing nutritional support to TB patients, respectively. Additionally, RePORT India (Regional Prospective Observational Research for Tuberculosis), established in 2013 under the Indo-US Vaccine Action Program (VAP), represents a collaborative research effort to address the TB threat both within India and globally.olitical commitment with increased and sustained financing. Case detection through quality-assured bacteriology, standardized treatment with supervision and patient support, an effective drug supply and management system, monitoring and evaluation system, and impact measurement. The WHO has set ambitious targets to end the global tuberculosis[13] (TB) epidemic by 2035. These goals include a 95 % reduction in TB deaths, a 90 % reduction in TB incidence, and the elimination of catastrophic costs for TB-affected households, compared to 2015 levels. The Global Strategy to achieve these targets is built on three pillars: (1) providing integrated, people-centered care and prevention to ensure early and universal access to diagnosis and treatment of all TB forms; (2) implementing bold policies and supportive systems, which involve strengthened government leadership, and collaboration with civil society and the private sector.

IV. Conclusion

Drug-resistant tuberculosis (TB) poses a formidable challenge to India's public health system. Addressing this issue demands a multifaceted approach that includes prevention, diagnosis, and treatment. The high prevalence of drug-resistant TB highlights the urgent need for enhanced surveillance and control measures. Combating drug-resistant TB requires prioritizing the strengthening of healthcare infrastructure and capacity building. Innovations in diagnostic technologies are crucial for the early detection and management of drug-resistant TB cases. Ensuring access to quality healthcare services, including proper medication and support, is vital for curbing the spread of drug-resistant TB. Collaborative efforts among government agencies, healthcare providers, and civil society are essential for effectively tackling drug-resistant TB. Advocacy and awareness campaigns play a key role in promoting adherence to TB treatment regimens and reducing drug resistance. Research and development should focus on novel therapies and vaccines to combat drug-resistant TB strains. Addressing socioeconomic factors is necessary to ensure equitable access to TB care and prevent the emergence of drug resistance. Strengthening infection control measures in healthcare settings is essential to prevent nosocomial transmission of drug-resistant TB. Integrating TB services into primary healthcare systems can improve early detection and treatment initiation for drug-resistant cases. Continuous monitoring and evaluation are necessary to assess the impact of interventions and guide future strategies against drug-resistant TB. International collaboration and support are crucial for addressing cross-border challenges posed by drug-resistant TB. Community engagement and involvement are vital for fostering a supportive environment for TB prevention and control efforts. Investments in research and development are needed to develop new drugs and diagnostics for drug-resistant TB. Political commitment and allocation of adequate resources are essential for sustaining long-term efforts to combat drug-resistant TB in India. Strengthening healthcare delivery systems and promoting patient-centered care are essential for improving outcomes in drug-resistant TB management. Scaling up access to quality-assured drugs and treatment regimens is necessary to ensure effective management of drug-resistant TB cases. Ultimately, a coordinated, comprehensive approach is essential to effectively address the challenge of drug-resistant TB and reduce its burden on India's healthcare system and society. To eliminate TB in India, it is essential to focus on person-centered care, address the social determinants of health, and embrace innovative solutions. By adopting a comprehensive and patient-focused strategy, India can overcome the barriers to TB control and pave the way for a healthier future for all its citizens. The MoHFW along with various development partners of the Health Ministry launched the Tuberculosis (TB) Mukt Bharat Abhiyaan in 2021 under the NSP India 2020–25 for TB Elimination in a major mission activity for ending the epidemic of TB by 2025.

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