GLOBAL TUBERCULOSIS REPORT

2023

World Health Organization

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Designed by minimum graphics

Cover design by Irwin Law

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Dr Tedros Adhanom Ghebreyesus
Director-General
World Health Organization

> *For millennia, our ancestors have suffered and died with tuberculosis, without knowing what it was, what caused it, or how to stop it. Today, we have knowledge and tools they could only have dreamed of. We have political commitment, and we have an opportunity that no generation in the history of humanity has had: the opportunity to write the final chapter in the story of TB.*

Dr Tereza Kasaeva
Director
WHO Global Tuberculosis Programme

“We have strong commitments with concrete targets, made by world leaders in the political declaration of the second UN high-level meeting on TB, which provide a strong impetus to accelerate the TB response. This report provides key data and evidence about the status of the TB epidemic and a review of progress, which can inform the translation of these commitments and targets into action in countries. We need all hands on deck to make the vision of ending TB a reality.”

Acknowledgements

The *Global tuberculosis report 2023* was produced by a core team of 13 people in the WHO Global Tuberculosis Programme: Taghreed Adam, Annabel Baddeley, Mathieu Bastard, Saskia den Boon, Anna Dean, Dennis Falzon, Katherine Floyd, Nebiat Gebreselassie, Marek Lalli, Irwin Law, Peter Nguhiu, Hazim Timimi and Takuya Yamanaka. The team was led by Katherine Floyd. Overall oversight was provided by the Director of the Global TB Programme, Tereza Kasaeva.

The data collection forms were developed by Hazim Timimi, with input from staff throughout the WHO Global Tuberculosis Programme. Hazim Timimi led and organized all aspects of data and code management, including the preparation and implementation of the web system used for the 2023 round of global tuberculosis (TB) data collection from 215 countries and areas, with support from Simone Gigli and Veemalla Thevi.

Data were reviewed by the following people at WHO headquarters: Annabel Baddeley, Mathieu Bastard, Saskia den Boon, Annemieke Brands, Anna Dean, Dennis Falzon, Medea Gegia, Licé Gonzalez Angulo, Avinash Kanchar, Alexei Korobitsyn, Marek Lalli, Cecily Miller, Francis Mhimbira, Carl-Michael Nathanson, Peter Nguhiu, Linh Nguyen, Liana Oganezova, Cicilia Gita Parwati, Samuel Schumacher, Lana Syed, Hazim Timimi, Sabine Verkuijl and Takuya Yamanaka. Financing data were also reviewed by Andrew Siroka (independent consultant). Data for the European Region were collected and validated jointly by the WHO Regional Office for Europe and the European Centre for Disease Prevention and Control (ECDC).

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Doris Ma Fat from the WHO Mortality and Burden of Disease team provided data from the WHO Mortality Database that were used to estimate TB mortality among HIV-negative people; and Juliana Daher and Mary Mahy (UNAIDS) provided epidemiological data that were used to estimate TB incidence and mortality among people with HIV.

The report is designed to optimize web or app-based access and use and has three major components: a core report document that focuses on the main findings and messages; webpages containing more detailed and digitized content, which are organized by topic area (comprising six standard topics and six featured topics); and a mobile app containing country, regional and global profiles as well as two slide-sets. Many people contributed to these three report components. Unless specified, those named below work in the WHO Global Tuberculosis Programme.

The production of the core report document was coordinated by Katherine Floyd and Irwin Law. The main text was written by Katherine Floyd, with contributions from Taghreed Adam, Mathieu Bastard, Nebiat Gebreselassie and Takuya Yamanaka. Irwin Law organized the preparation of all figures and tables, which were produced by Taghreed Adam, Mathieu Bastard, Saskia den Boon, Anna Dean, Peter Dodd (Sheffield University, United Kingdom of Great Britain and Northern Ireland), Dennis Falzon, Irwin Law, Peter Nguhiu, Andrew Siroka (independent consultant), Hazim Timimi and Takuya Yamanaka. Annexes 1, 3 and 6 were prepared by Katherine Floyd; Annexes 2 and 4 by Hazim Timimi; and Annex 5 by Mathieu Bastard, Anna Dean and Katherine Floyd, with inputs from Nimalan Arinaminpathy (Imperial College London, United Kingdom).

The report webpages include content for six standard topics. These are: 1) TB disease burden, comprising TB incidence (prepared by Mathieu Bastard and Katherine Floyd), TB mortality (prepared by Mathieu Bastard and Katherine Floyd), drug-resistant TB (prepared by Anna Dean, Peter Dodd and Hazim Timimi) and national TB prevalence surveys (prepared by Katherine Floyd and Irwin Law); 2) TB diagnosis and treatment, prepared by Katherine Floyd and Takuya Yamanaka, with contributions from Nazir Ismail and Fuad Mirzayev; 3) TB prevention and screening, prepared by Annabel Baddeley, Saskia den Boon, Dennis Falzon and Hazim Timimi, with contributions from Avinash Kanchar and Cecily Miller; 4) Financing for TB prevention, diagnostic and treatment services, prepared by Taghreed Adam, Peter Nguhiu, Andrew Siroka (independent consultant) and Takuya Yamanaka, with contributions from Katherine Floyd; 5) Universal health coverage (UHC) and TB determinants, prepared by Takuya Yamanaka with contributions from Taghreed Adam, Delia Boccia (London School of Hygiene and Tropical Medicine, United Kingdom), Katherine Floyd and Ernesto Jaramillo; and 6) TB research and innovation, prepared by Nebiat Gebreselassie and

Irwin Law, with contributions from Saskia den Boon, Dennis Falzon, Katherine Floyd, Medea Gegia, Nazir Ismail, Alexei Korobitsyn, Cecily Miller, Fuad Mirzayev and Matteo Zignol. The interactive graphics that appear in the webpages, which allow users to visualize data values by hovering over data points, were prepared by Mathieu Bastard, Irwin Law, Peter Nguhiu, Hazim Timimi and Takuya Yamanaka.

The report team is very grateful to Nimalan Arinaminpathy and Peter Dodd for their key contributions to the estimates of TB disease burden that are included in the core report document and the standard set of report webpages. Nimalan Arinaminpathy produced all estimates of TB incidence and mortality for the period 2020–2022 that were based on country or region-specific dynamic models (26 and 23 countries, respectively). Peter Dodd produced global, regional and national estimates of the incidence of rifampicin-resistant TB (RR-TB) in the period 2015–2022, a global estimate of the incidence of isoniazid-resistant TB in 2022, a global estimate of the number of deaths caused by RR-TB in 2022 and age-sex disaggregated estimates for TB incidence and mortality at global, regional and country levels in 2022. The report team is also grateful to Philippe Glaziou (who led WHO's work related to TB disease burden estimation from 2008–2022) for his advice on the use, implementation and updating (as appropriate) of previous methods and codes; and to Sandip Mandal (John Snow India Private Limited) for his key role in the production of estimates of TB incidence and mortality for India.

The report webpages include content for six featured topics. These are: 1) the political declaration from the United Nations (UN) high-level meeting on TB that was held in September 2023, prepared by Nebiat Gebreselassie; 2) new treatment for drug-resistant TB, prepared by Fuad Mirzayev; 3) international donor funding for TB, prepared by Peter Nguhiu, with contributions from Taghreed Adam and Katherine Floyd; 4) TB in prisons, prepared by Kerri Viney, with contributions from Pedro Avedillo, Annabel Baddeley, Andrei Dadu, Katherine Floyd, Christian Gunneberg, Ernesto Jaramillo, Farai Mavhunga, Hazim Timimi and Askar Yedilbayev; 5) findings from recent TB epidemiological reviews in Nigeria and the United Republic of Tanzania, prepared by Marek Lalli and Charalambos Sismanidis, with contributions from Mathieu Bastard and Peter Nguhiu; and 6) multisectoral accountability in the TB response, prepared by Hannah Monica Dias, Tereza Kasaeva and Liana Oganezova.

The report landing page and all of the other report webpages were prepared by Olivier Beauvais, Irwin Law, Hazim Timimi and Takuya Yamanaka, with overall guidance and oversight provided by Hazim Timimi and Patrick Tissot.

The technical appendix that explains the methods used to produce estimates of TB disease burden was prepared by Mathieu Bastard, Anna Dean, Hazim Timimi, Nimalan Arinaminpathy (Imperial College, London, United Kingdom) and Peter Dodd (University of Sheffield, United Kingdom).

The data and other content provided in the mobile app were prepared by Katherine Floyd, Irwin Law and Hazim Timimi. The app was first developed by the WHO Global Tuberculosis Programme in collaboration with Adappt in 2019 and has subsequently been maintained by Adappt throughout the year and then updated on an annual basis. The report team is very appreciative of the excellent work done by Adappt.

The web-based versions of global, regional and country profiles that are available via the report landing page were prepared by Hazim Timimi. Simplified versions for a more general audience were prepared by Hannah Monica Dias and Yi Wang.

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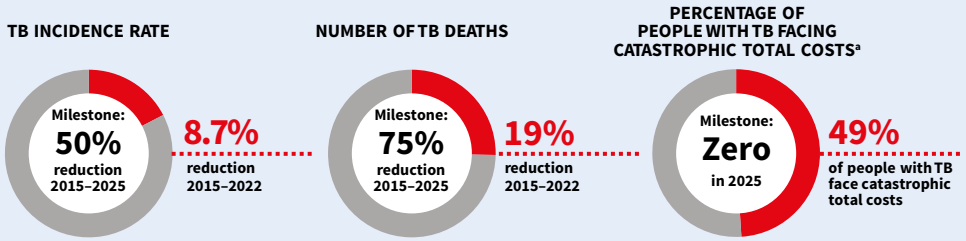
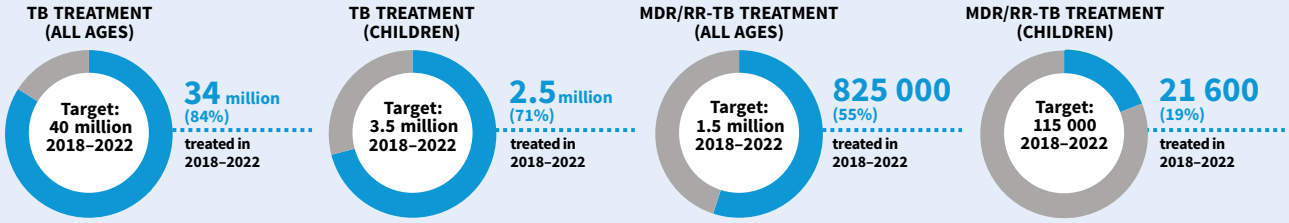
Abbreviations

AIDS	acquired immune deficiency syndrome
ART	antiretroviral therapy
BCG	bacille Calmette-Guérin
BPaLM	bedaquiline, pretomanid, linezolid and moxifloxacin
BRICS	Brazil, the Russian Federation, India, China and South Africa
CSV	comma separated value
CI	confidence interval
COVID-19	coronavirus disease 2019
DST	drug susceptibility testing
ECDC	European Centre for Disease Prevention and Control
GDP	gross domestic product
GHO	Global health observatory
HBC	high burden country
HIV	human immunodeficiency virus
IGRA	interferon-gamma release assay
IHME	Institute for Health Metrics and Evaluation
LMICs	low- and middle-income countries
MAF-TB	multisectoral accountability framework for TB
MDR-TB	multidrug-resistant TB
NTP	national TB programme
OECD	Organization for Economic Co-operation and Development
PPP	purchasing power parity
PPPR	pandemic preparedness, prevention and response
RR-TB	rifampicin-resistant TB
SCI	service coverage index
SDG	Sustainable Development Goal
SHA	System of Health Accounts
SRS	sample registration system
TB	tuberculosis
UHC	universal health coverage
UI	uncertainty interval
UN	United Nations
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNPD	UN Population Division
VR	vital registration
USAID	United States Agency for International Development
WHO	World Health Organization
WRD	WHO-recommended rapid diagnostic test
XDR-TB	extensively drug-resistant TB

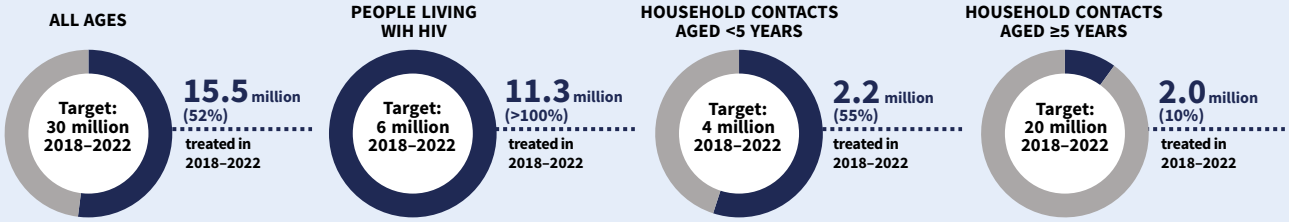
WHO End TB Strategy: 2025 milestones



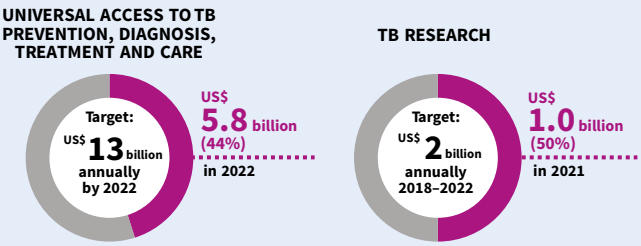
2018 UN high-level meeting on TB: treatment targets



2018 UN high-level meeting on TB: TB preventive treatment targets



2018 UN high-level meeting on TB: funding targets



MDR/RR-TB, multidrug-resistant TB/rifampicin-resistant TB.

[a] Total costs includes direct medical expenditures, non-medical expenditures and income losses. This indicator is not the same as the SDG indicator for catastrophic health expenditures. See **Box 5** for further explanation.

1. Introduction

Tuberculosis (TB) is a preventable and usually curable disease. Yet in 2022, TB was the world's second leading cause of death from a single infectious agent, after coronavirus disease (COVID-19), and caused almost twice as many deaths as HIV/AIDS. More than 10 million people continue to fall ill with TB every year. Urgent action is required to end the global TB epidemic by 2030, a goal that has been adopted by all Member States of the United Nations (UN) and the World Health Organization (WHO) *(1, 2)*.

TB is caused by the bacillus *Mycobacterium tuberculosis*, which is spread when people who are sick with TB expel bacteria into the air (e.g. by coughing). About a quarter of the global population is estimated to have been infected with TB *(3)*. Following infection, the risk of developing TB disease is highest in the first 2 years (approximately 5%), after which it is much lower *(4)*.[1] Some people will clear the infection *(5, 6)*. Of the total number of people who develop TB disease each year, about 90% are adults, with more cases among men than women. The disease typically affects the lungs (pulmonary TB) but can affect other sites as well.

Basic facts about TB are provided in **Annex 1**.

Without treatment, the death rate from TB disease is high (about 50%) *(7)*. With treatments currently recommended by WHO (a 4–6 months course of anti-TB drugs), about 85% of people with TB can be cured. Regimens of 1–6 months are available to treat TB infection. Universal health coverage (UHC) is necessary to ensure that all people who need treatment for TB disease or infection can access these treatments. The number of people acquiring infection and developing disease (and in turn the number of deaths caused by TB) can also be reduced through multisectoral action to address TB determinants such as poverty, undernourishment, HIV infection, smoking and diabetes.

Some countries have already reduced their burden of TB disease to fewer than 10 cases and less than one death per 100 000 population per year. Research breakthroughs (e.g. a new vaccine) are needed to rapidly reduce the number of new cases each year (i.e. TB incidence) worldwide to the levels already achieved in these low-burden countries.

Political commitment to ending the TB epidemic has stepped up in recent years. The UN held its first-ever high-level meeting on TB in 2018 *(8)*. With global progress off track and in the wake of setbacks during the COVID-19 pandemic, a second UN high-level meeting on TB was held on 22 September 2023. The resulting political declaration reaffirms existing commitments and targets and includes new ones for the period 2023–2027 *(9)*.

This WHO global TB report follows just over 1 month later. It provides a comprehensive and up-to-date assessment of the status of the TB epidemic and progress in the response at global, regional and national levels, in the context of global commitments, strategies and targets.

As with previous WHO global TB reports, the 2023 edition is based primarily on data gathered by WHO from national ministries of health in annual rounds of data collection.[2] In 2023, 192 countries and areas (out of 215) with more than 99% of the world's population and TB cases reported data (**Annex 2**), including all high TB burden countries (**Annex 3**). The report also draws on monthly or quarterly national TB case notification data, which have been collected since the start of the COVID-19 pandemic *(10, 11)*, and databases maintained by other UN agencies and the World Bank.

The report has three main components. There is a short main report that focuses on key findings and messages (this document); webpages that provide more detailed and digitized information, including many interactive graphics;[3] and an app that contains country, regional and global profiles as well as two slide sets (**Annex 4**). All components can be accessed from the report landing page on the WHO website, and all data can be downloaded from WHO's online global TB database *(11)*. The report format ensures web or app-based availability of all content in relatively small and "bite-sized" chunks, which facilitates navigation, reading and use.

The top findings and messages of the 2023 report are highlighted in **Box 1**.

[1] For people with a long-established infection, empirical data suggest an annual risk of about 10–20 per 100 000 individuals.

[2] WHO has published a global TB report every year since 1997. Annual data are reported by national TB programmes (NTPs) or the national entity responsible for TB surveillance.

[3] The webpages cover six standard topics: TB disease burden; TB diagnosis and treatment; TB prevention and screening; TB financing; UHC and TB determinants; and TB research and innovation. There are also webpages on "featured topics", which this year are: new treatments for drug-resistant TB; TB in prisons; international donor funding for TB; the 2023 UN high-level meeting on TB; multisectoral accountability for the TB response; and national TB epidemiological reviews.

Box 1. Top findings and messages in the 2023 report

There was a major global recovery in the number of people diagnosed with TB and treated in 2022, after 2 years of COVID-related disruptions. This has started to reverse or moderate the damaging impact of the pandemic on the number of people dying from or falling ill with TB. However, TB remained the world's second leading cause of death from a single infectious agent in 2022, after COVID-19, and global TB targets have either been missed or remain off track.

The reported global number of people newly diagnosed with TB was 7.5 million in 2022. This is the highest number since WHO began global TB monitoring in 1995, above the pre-COVID baseline (and previous historical peak) of 7.1 million in 2019, and up from 5.8 million in 2020 and 6.4 million in 2021. The number in 2022 probably includes a sizeable backlog of people who developed TB in previous years, but whose diagnosis and treatment was delayed by COVID-related disruptions that affected access to and provision of health services.

India, Indonesia and the Philippines, which collectively accounted for a large share (≥60%) of the global reductions in the number of people newly diagnosed with TB in 2020 and 2021, all recovered to above 2019 levels in 2022.

Globally in 2022, TB caused an estimated 1.30 million deaths[a] (95% UI: 1.18–1.43 million). This was down from best estimates of 1.4 million in both 2020 and 2021 and almost back to the level of 2019.[b]

COVID-related disruptions are estimated to have resulted in almost half a million excess deaths from TB in the three years 2020–2022, compared with the number that would have occurred if pre-pandemic trends had been maintained.

The net reduction in the global number of deaths caused by TB from 2015 to 2022 was 19%, far from the WHO End TB Strategy milestone of a 75% reduction by 2025. Progress is much better in the WHO African and European regions, and 47 countries achieved reductions of at least 35%.[c]

Worldwide, an estimated 10.6 million people (95% UI: 9.9–11.4 million) developed TB in 2022, up from best estimates of 10.3 million in 2021 and 10.0 million in 2020. A return to the pre-pandemic downward trend may occur in 2023 or 2024.

The global gap between the estimated number of people developing TB (incident cases) and the reported number of people newly diagnosed with TB (notified cases) narrowed to a best estimate of 3.1 million in 2022, down from around 4 million in both 2020 and 2021 and back to the pre-pandemic level of 2019.

Globally, the estimated TB incidence rate (new cases per 100 000 population per year) was 133 (95% UI: 124–143) in 2022. The net reduction from 2015 to 2022 was 8.7%, far from the WHO End TB Strategy milestone of a 50% reduction by 2025. Progress is much better in the WHO African and European regions, and 83 countries achieved reductions of at least 20%.[c]

Thirty high TB burden countries accounted for 87% of the world's TB cases in 2022 and two-thirds of the global total was in eight countries: India (27%), Indonesia (10%), China (7.1%), the Philippines (7.0%), Pakistan (5.7%), Nigeria (4.5%), Bangladesh (3.6%) and the Democratic Republic of the Congo (3.0%).

In 2022, 55% of people who developed TB were men, 33% were women and 12% were children (aged 0–14 years).

Globally, an estimated 410 000 people (95% UI: 370 000–450 000) developed multidrug-resistant or rifampicin-resistant[d] TB (MDR/RR-TB) in 2022. The number of people diagnosed and started on treatment was much lower: 175 650 people in 2022, equivalent to about two in five of those in need and still below the pre-pandemic level of 181 533 people in 2019.

New national surveys of TB disease and up-to-date cause-of-death data from national or sample vital registration systems of high quality and coverage are needed for more accurate estimation of TB disease burden in the post-COVID period.

Global targets set at the first UN high-level meeting on TB for the 5-year period 2018–2022 were not achieved.

- 34 million people were treated for TB, 84% of the 5-year target of 40 million.
- 15.5 million people were initiated on TB preventive treatment, 52% of the 5-year target of 30 million. This included 3.8 million people in 2022, above the pre-pandemic level of 3.6 million in 2019.
- US$ 5.8 billion[e] was available for provision of TB diagnosis, treatment and prevention services in 2022, below pre-COVID levels and less than half of the target of at least US$ 13 billion per year by 2022.
- investment in TB research averaged just under US$ 1 billion per year, less than half of the US$ 2 billion target.[f]

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 annual household income),[g] far from the WHO End TB Strategy target of zero. This shows that there are major economic and financial barriers to accessing and completing TB treatment, which need to be addressed through faster progress towards UHC and better levels of social protection.

Treatment success rates have improved: to 88% for people treated for drug-susceptible TB and 63% for people with MDR/RR-TB.

Ending the global TB epidemic requires translating the commitments made at the 2023 UN high-level meeting on TB into action.

[a] This total includes 167 000 deaths from TB among people with HIV, which are officially classified as deaths from HIV/AIDS.
[b] Estimates for 2010–2021 have been revised downwards compared with those published in 2022, mainly due to revisions for India (**Box 4**).
[c] This reduction corresponds to the first (2020) milestone of the End TB Strategy (**Box 2**).
[d] Rifampicin is the most powerful first-line anti-TB drug. MDR-TB is defined as resistance to rifampicin and isoniazid.
[e] In constant US$ values for 2022.
[f] The source of these data is reports published by Treatment Action Group.
[g] This indicator is not the same as the SDG indicator for catastrophic health expenditures (**Box 5**).

2. Global TB commitments, strategy and targets

In 2014 and 2015, all WHO and UN Member States committed to ending the TB epidemic, through their adoption of WHO's End TB Strategy (**Box 2**) and the UN Sustainable Development Goals (SDGs) *(1, 2)*. The strategy included milestones (for 2020 and 2025) and targets (for 2030 and 2035) for large reductions in the TB incidence rate (new cases per 100 000 population per year), the absolute number of deaths caused by TB, and costs faced by TB patients and their households.

Reaching the milestones and targets for reductions in TB incidence required an annual decline in the TB incidence rate of 4–5% per year by 2020, accelerating to 10% per year by 2025 and then to an average of 17% per year from 2025 to 2035. Reaching the milestones and targets for reductions in the number of deaths caused by TB required not only these declines in TB incidence, but also reductions in the case fatality ratio (the percentage of people with TB who die from the disease). The global

Box 2. The End TB Strategy at a glance

VISION	A WORLD FREE OF TB — zero deaths, disease and suffering due to TB			
GOAL	**END THE GLOBAL TB EPIDEMIC**			
INDICATORS	MILESTONES		TARGETS	
	2020	2025	2030	2035
Percentage reduction in the absolute number of TB deaths[a] (compared with 2015 baseline)	35%	75%	90%	95%
Percentage reduction in the TB incidence rate (compared with 2015 baseline)	20%	50%	80%	90%
Percentage of TB-affected households facing catastrophic total costs due to TB[b] (level in 2015 unknown)	0%	0%	0%	0%

PRINCIPLES

1. Government stewardship and accountability, with monitoring and evaluation
2. Strong coalition with civil society organizations and communities
3. Protection and promotion of human rights, ethics and equity
4. Adaptation of the strategy and targets at country level, with global collaboration

PILLARS AND COMPONENTS

1. INTEGRATED, PATIENT-CENTRED CARE AND PREVENTION

A. Early diagnosis of TB including universal drug-susceptibility testing, and systematic screening of contacts and high-risk groups
B. Treatment of all people with TB including drug-resistant TB, and patient support
C. Collaborative TB/HIV activities, and management of comorbidities
D. Preventive treatment of persons at high risk, and vaccination against TB

2. BOLD POLICIES AND SUPPORTIVE SYSTEMS

E. Political commitment with adequate resources for TB care and prevention
F. Engagement of communities, civil society organizations, and public and private care providers
G. Universal health coverage policy, and regulatory frameworks for case notification, vital registration, quality and rational use of medicines, and infection control
H. Social protection, poverty alleviation and actions on other determinants of TB

3. INTENSIFIED RESEARCH AND INNOVATION

I. Discovery, development and rapid uptake of new tools, interventions and strategies
J. Research to optimize implementation and impact, and promote innovations

[a] This indicator is for the combined total of TB deaths in HIV-negative and HIV-positive people. Deaths from TB among HIV-positive people are officially classified as deaths caused by HIV/AIDS, with TB as a contributory cause.

[b] This indicator is not the same as the SDG indicator for catastrophic health expenditures. See **Box 5** for further explanation.

TABLE 1

Global targets set in 2018 at the first UN high-level meeting on TB

INDICATOR	TARGET
Number of people with TB disease treated in the five years 2018–2022	40 million people, including: • 3.5 million children • 1.5 million people with drug-resistant TB, including 115 000 children
Number of people provided with TB preventive treatment in the five years 2018–2022	At least 30 million people, including: • 4 million children under 5 years of age who are household contacts of people diagnosed with TB • 20 million people in older age groups who are household contacts of people diagnosed with TB • 6 million people living with HIV
Annual funding for universal access to quality prevention, diagnosis, treatment and care of TB	At least US$ 13 billion per year by 2022
Annual funding for TB research	US$ 2 billion annually in the five years 2018–2022

case fatality ratio needed to fall to 10% by 2020 and then to 6.5% (a level already achieved in high-income countries) by 2025. Key requirements to reach the milestones and targets were defined within the three pillars of the End TB Strategy (**Box 2**). They included provision of TB prevention, diagnostic and treatment services within the context of progress towards UHC and social protection; multisectoral actions to address broader social and economic determinants of TB; and technological breakthroughs, such as a new TB vaccine by 2025.

The third target of the End TB Strategy, that no TB patients and their households face catastrophic total costs[1] as a result of the disease, was set in recognition of the fact that removal of financial and economic barriers to accessing TB diagnosis and treatment is a prerequisite for achieving the milestones and targets for reductions in TB incidence and TB mortality. "Catastrophic" is defined as direct medical expenditures, direct non-medical expenditures and indirect costs (e.g. income losses) that sum to more than 20% of household income.

Further details about the rationale for the milestones and targets and how they were defined is available elsewhere *(12)*.

In 2018, the UN General Assembly held its first-ever high-level meeting on TB. Commitments to the SDGs and End TB Strategy were reaffirmed and new global targets, for mobilization of funding and provision of treatment (**Table 1**), were agreed upon *(8)*.[2] A second high-level meeting was held in September 2023, alongside high-level meetings about UHC and pandemic prevention, preparedness and response (PPPR). The political declaration *(9)* includes new commitments and targets for the period 2023–2027 (**Table 2**, **Table 3**).

TABLE 2

Global targets set in 2023 at the second UN high-level meeting on TB

INDICATOR	GLOBAL TARGET
TB treatment coverage (percentage of the estimated number of people who develop TB disease each year who are provided with quality-assured diagnosis and treatment)	90% by 2027 (equivalent to up to 45 million people globally in the 5-year period 2023–2027, including up to 4.5 million children and up to 1.5 million people with drug-resistant TB)
Coverage of TB preventive treatment (percentage of people at high risk of developing TB disease who are provided with TB preventive treatment)	90% by 2027 (equivalent to up to 45 million people globally in the 5-year period 2023–2027, including 30 million household contacts of people with TB and 15 million people living with HIV)
Coverage of rapid diagnostic testing for TB (percentage of those diagnosed with TB who were initially tested with a WHO-recommended rapid molecular test)	100% by 2027
Coverage of health and social benefits package for people with TB	100% by 2027
Availability of new TB vaccines that are safe and effective	Rollout initiated, preferably within 5 years
Annual funding for universal access to quality prevention, diagnosis, treatment and care for TB	US$ 22 billion by 2027, US$ 35 billion by 2030
Annual funding for TB research	US$ 5 billion by 2027

[1] This indicator is not the same as the SDG indicator for catastrophic health expenditures (see **Box 5**).

[2] The meeting followed a WHO global ministerial conference in 2017 *(13)*.

TABLE 3

Highlights of commitments and requests at the second UN high-level meeting on TB in 2023

a) Commitments

TOPIC OR THEME	COMMITMENT
Provide comprehensive care to all people with TB	Strengthen the provision of comprehensive care for all people with TB, with particular attention to people who are vulnerable or in vulnerable situations (e.g. people with HIV, people with TB-associated disabilities, older people, migrants, refugees, internally displaced people, and pregnant and lactating women), using specific models of care such as nutritional, mental health and psychosocial support, social protection, rehabilitation and palliative care
	Scale-up comprehensive efforts to close longstanding gaps in the prevention, diagnosis, treatment and care of children
Address the crisis of drug-resistant TB	Work towards the achievement of universal, equitable and affordable access to WHO-recommended diagnostics and drug susceptibility tests, and all-oral shorter-duration treatment regimens for people with drug-resistant TB, complemented by monitoring and management of side-effects, together with care and support to improve treatment outcomes
Build on interlinkages across the global health agendas of TB, UHC and PPPR, to strengthen the TB response	Establish TB services as essential elements of national and global strategies to advance UHC, address antimicrobial resistance and strengthen PPPR
	Integrate systematic screening, prevention, treatment and care of TB, and related health conditions, within primary health care, including community-based health services
	Invest in public health infrastructure and the health workforce
Address TB during health and humanitarian emergencies	Safeguard TB services as essential health services during humanitarian and health emergencies
Strengthen the engagement of civil society and communities affected by TB	Intensify national efforts to create enabling legal and social policy frameworks to combat inequalities, and to eliminate all forms of TB-related stigma, discrimination and other human rights barriers and violations
	Strengthen the meaningful engagement of parliaments, civil society, and TB-affected local communities, including young people and women, in all aspects of the TB response, to ensure equitable and people-centred access to TB services, with increased and sustained investments, especially in community initiatives
Enable and strengthen TB research	Create an enabling environment for TB research and innovation across Member States and partners
	Strengthen research capacity and collaboration through TB research platforms and networks across the public and private sectors, academia and civil society
	Accelerate the research, development and roll-out of safe, effective, affordable and accessible vaccines, preferably within the next 5 years, including through leveraging global collaboration mechanisms and WHO initiatives such as the accelerator council for new TB vaccines
Promote access to affordable medicines	Promote equitable access to affordable, safe, effective and quality medicines, such as generics, vaccines, diagnostics and health technologies, including through the Stop TB Partnership/Global Drug Facility, to ensure availability and access to quality-assured and affordable commodities recommended by WHO
Strengthen multisectoral accountability	Support the WHO multisectoral accountability framework for TB by strengthening high-level multisectoral accountability and review mechanisms, in line with national contexts, defining the roles and responsibilities of relevant sectors and stakeholders with the meaningful engagement of people and communities affected by TB
	Develop and implement ambitious, costed national TB strategic plans or health strategies with a multisectoral approach

b) Requests

TOPIC OR THEME	REQUEST
Role of WHO	WHO is requested to continue providing global leadership to support Member States to build a resilient response to TB as an integral part of the UHC agenda, and to also address the drivers and determinants of the epidemic, including in the context of health and humanitarian emergencies, with multisectoral engagement, the provision of normative guidance and technical support, and through monitoring, reporting and review of progress, and by advancing the TB research and innovation agenda
Report and review progress	The UN Secretary-General, with the support of WHO, is requested to report, as part of his annual SDG report, on the global effort to end TB
	The UN Secretary-General, with the support of WHO, is requested to present a report to the UN General Assembly in 2027, on the progress achieved towards realizing the commitments made in the 2023 political declaration on TB
	Heads of state and government are requested to undertake a comprehensive review of progress at a UN high-level meeting on TB in 2028

HIV: human immunodeficiency virus; PPPR: pandemic preparedness, prevention and response; UHC: universal health coverage; UN: United Nations; WHO: World Health Organization

3. Main findings and messages

There was a major global recovery in the number of people diagnosed with TB and treated in 2022, after 2 years of COVID-related disruptions. This has started to reverse or moderate the damaging impact of the pandemic on the number of people dying from or falling ill with TB.

However, TB remained the world's second leading cause of death from a single infectious agent in 2022, after COVID-19, and caused almost twice as many deaths as HIV/AIDS. Global targets for improvements in TB treatment, TB preventive treatment and funding set at the first UN-high-level meeting on TB in 2018 have been missed and global TB targets for reductions in TB disease burden remain off track.

Ending the global TB epidemic requires translating the commitments made at the 2023 UN high-level meeting on TB into action.

TB case notifications

Rebound to beyond pre-COVID levels in 2022

The most obvious and immediate impact on TB of disruptions caused by the COVID-19 pandemic was a large global fall in the number of people newly diagnosed with TB and reported (i.e. officially notified). Following large increases between 2017 and 2019, there was a reduction of 18% between 2019 and 2020, from 7.1 million to 5.8 million, with a partial recovery to 6.4 million in 2021.

Globally in 2022, 7.5 million people were newly diagnosed with TB and officially notified as a TB case (**Fig. 1**). This was a rebound to above the pre-COVID level (7.1 million in 2019), 16% above the level of 2021, 28% above the level of 2020, and the highest number for a single year since WHO started global TB monitoring in the mid-1990s. The substantial increase in 2022 shows that there has been a good recovery in access to and provision of health services in many (but not all) countries. It also probably reflects diagnosis of a sizeable backlog of people who developed TB in previous years but whose diagnosis was delayed due to COVID-related disruptions, and an increase in the number of people falling ill with TB.

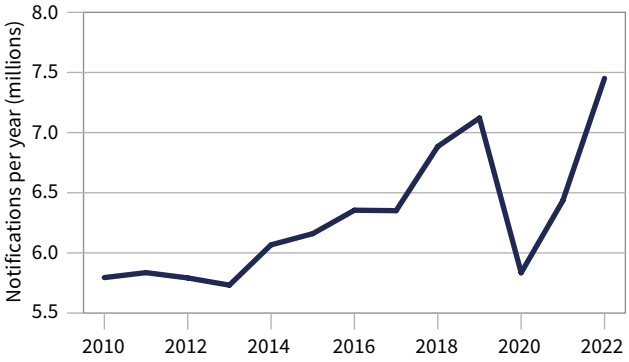
At regional level, trends in case notifications before, during and in the aftermath of the COVID-19 pandemic vary (**Fig. 2**).

The pattern in the WHO South-East Asia Region was very similar to the global trend, with a large reduction (-24%) between 2019 and 2020 followed by a partial recovery in 2021 and then a rebound to above the pre-COVID level in 2022; indeed, it is this region that drove the trend at global level. There was a comparable pattern in the WHO Region of the Americas.

Notifications in the WHO Eastern Mediterranean Region had already recovered to 2019 levels in 2021, with a further increase in 2022 (mostly influenced by trends in Pakistan, the country with the highest burden of TB in the region).

FIG. 1

Global trend in case notifications of people newly diagnosed with TB, 2010–2022



In the WHO European Region, notifications fell at a rate above the historical trend in 2020, increased in 2021 (likely representing some backlog from 2020) and then resumed a decline similar to the historical trend in 2022.

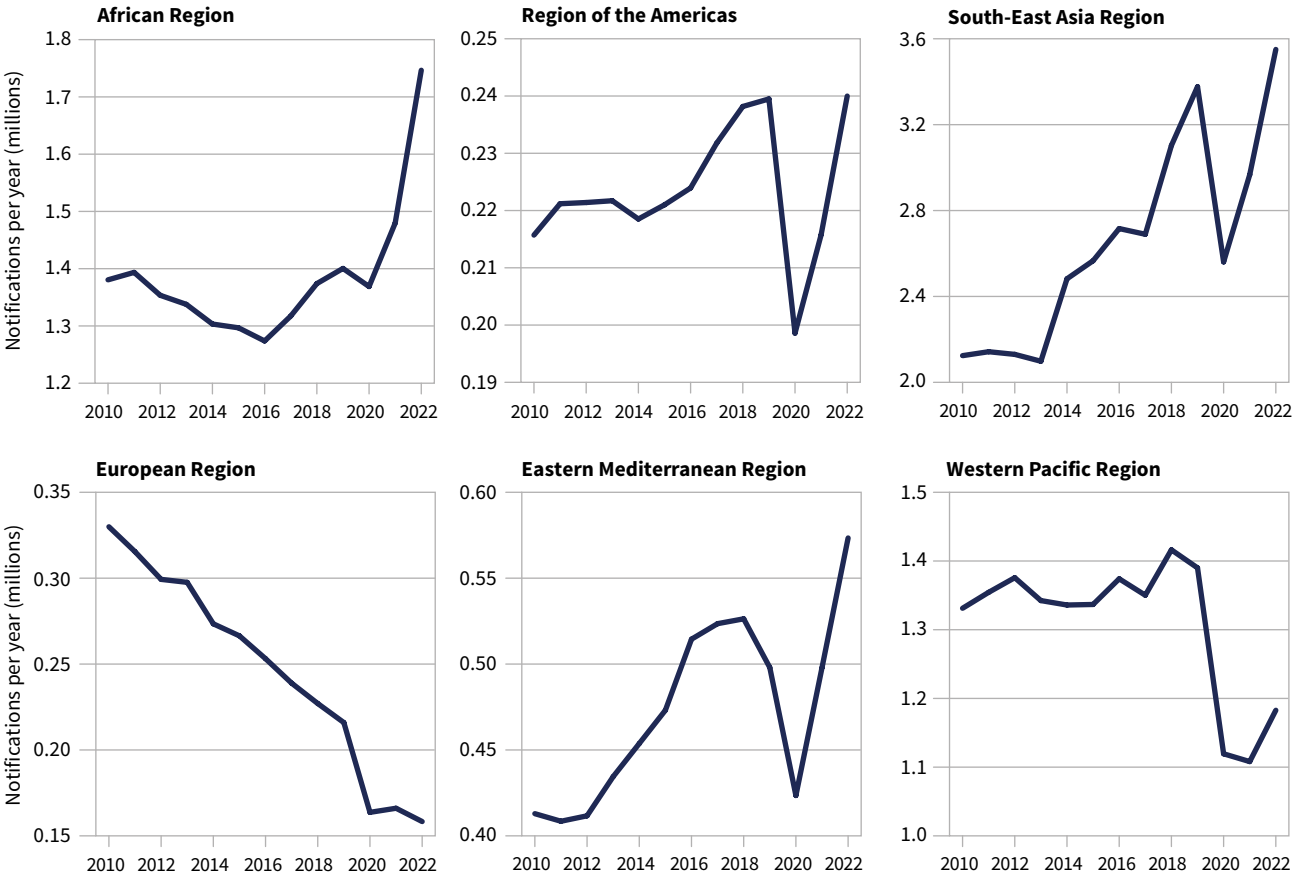
In the WHO Western Pacific Region, there was a big drop in case notifications in 2020, a further fall in 2021 and a partial recovery (increase) in 2022. However, trends among countries in this region varied. In China, which accounts for about half of total notifications in the region, notifications have been declining consistently for more than 10 years (**Fig. 3**). In most other countries in the region, including three high TB burden countries (Cambodia, the Philippines and Viet Nam), case notifications fell in either 2020 or 2021 but then recovered to 2019 levels (or beyond) in 2022 (**Fig. 3**).

It was striking that notifications in the WHO African Region increased throughout the pandemic, suggesting that any COVID-related disruptions had a limited impact on TB case detection.

At country level, the 30 high TB burden and three

FIG. 2

Trends in case notifications of people newly diagnosed with TB by WHO region, 2010–2022



global TB watchlist countries[1] can be categorized into six groups, according to the timing and degree of disruptions to TB notifications during the COVID-19 pandemic and subsequent patterns of recovery in its aftermath (**Fig. 3**).

The largest group consists of 13 countries in which there were major reductions in TB case notifications in 2020 or 2021, followed by a rebound to 2019 levels or beyond in 2022 (**Fig. 3a**). This included the three countries that accounted for a large share (≥60%) of the global reductions in 2020 and 2021: India, Indonesia and the Philippines. In a further six countries, there were reductions between 2019 and 2021, followed by a partial recovery in 2022 (**Fig. 3b**).

Nine countries reported either increased notifications throughout the pandemic and its aftermath or declines that were consistent with historical trends, suggesting no or only limited COVID-related disruptions to TB case detection (**Fig. 3c**, **Fig. 3d**). The countries in these two groups were mostly in the WHO African Region, consistent with regional data (**Fig. 2**).

Five countries had unusual patterns that are difficult to explain: either a reduction in 2020, an apparent recovery in 2021 and then a reduction in 2022 (**Fig. 3e**); or a decline consistent with historical trends during the main years of the pandemic (2020 and 2021) followed by an increase in 2022 that was in stark contrast to pre-2022 trends (**Fig. 3f**). To better understand these patterns, further assessment of surveillance, epidemiological and programmatic data is required.

Patterns of impact and recovery in 2020, 2021 and 2022, in percentage terms and relative to the baseline of 2019, are shown for the 30 high TB burden and three global TB watchlist countries in **Fig. 4**. As highlighted in previous global TB reports *(14, 15)*, the countries with the largest relative reductions in either 2020 or 2021 were (ordered according to the size of the relative reduction) Myanmar, the Philippines, Mongolia, Lesotho, Indonesia, Cambodia, Zimbabwe, India, Viet Nam and Bangladesh (all >20%).

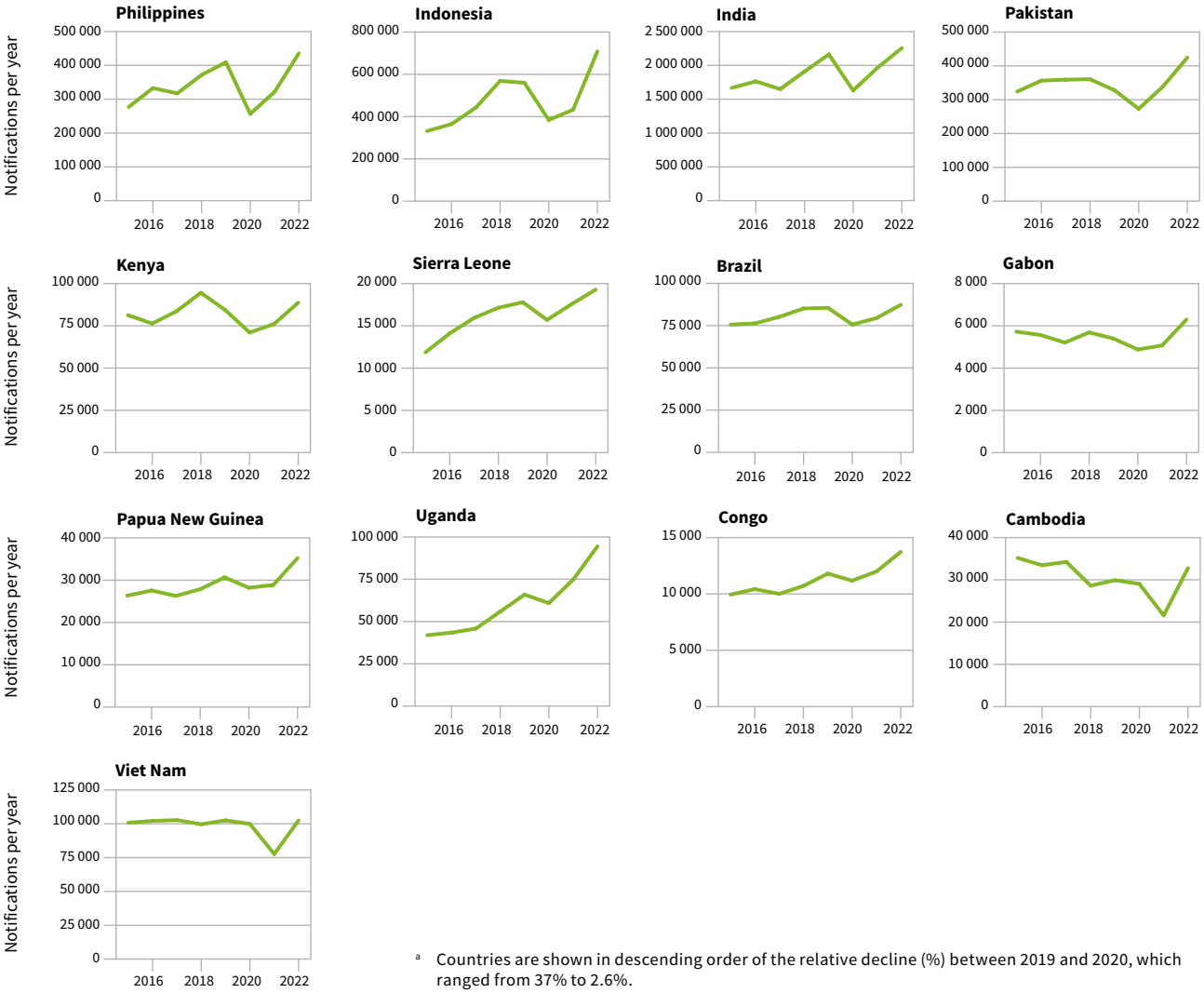
Reasons for region and country variation in TB notification trends between 2019 and 2022 include differences in when they were first affected by the COVID-19 pandemic and the timing of subsequent waves of

[1] In 2021, WHO updated its three lists of high burden countries for TB, MDR/RR-TB and HIV-associated TB. The lists are for 2021–2025, replacing the previous lists for 2016–2020, and are explained in **Annex 3**. The three countries that exited the TB list (Cambodia, the Russian Federation and Zimbabwe) were defined as global TB watchlist countries.

FIG. 3

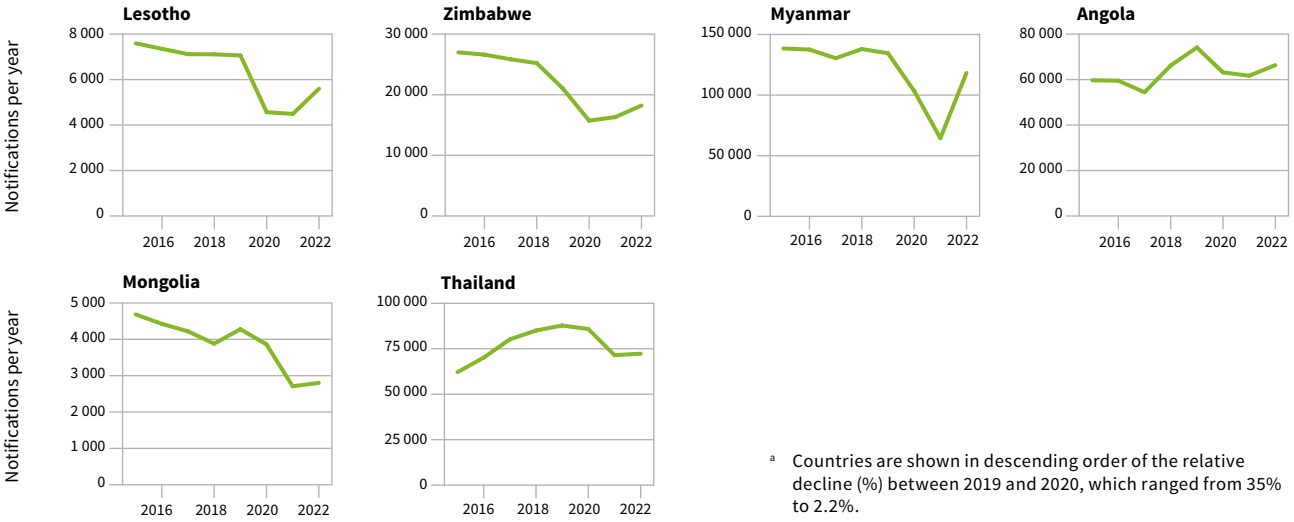
Case notifications of people newly diagnosed with TB in the 30 high TB burden and 3 global TB watchlist countries, categorized according to the timing and degree of disruptions during the COVID-19 pandemic and its aftermath, 2020–2022

(a) Negative impact in 2020[a] or 2021, recovery to 2019 levels or beyond in 2022



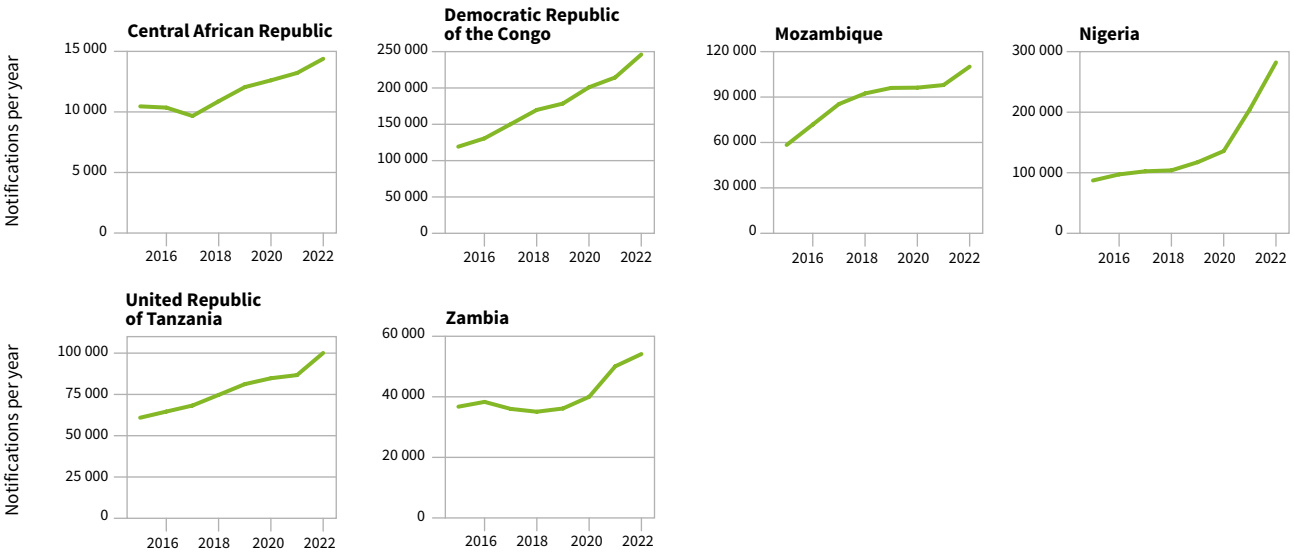
[a] Countries are shown in descending order of the relative decline (%) between 2019 and 2020, which ranged from 37% to 2.6%.

(b) Negative impact in 2020[a]–2021, partial recovery in 2022

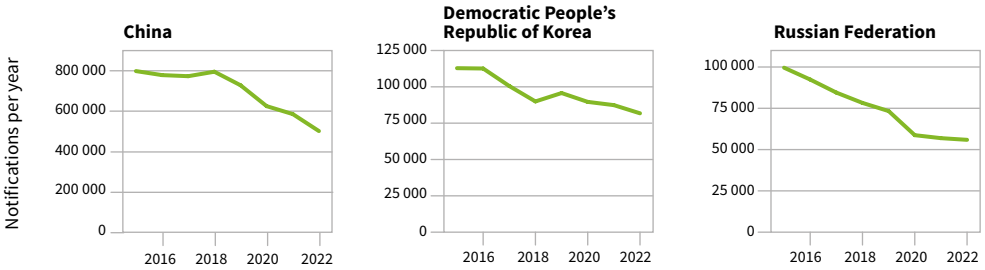


[a] Countries are shown in descending order of the relative decline (%) between 2019 and 2020, which ranged from 35% to 2.2%.

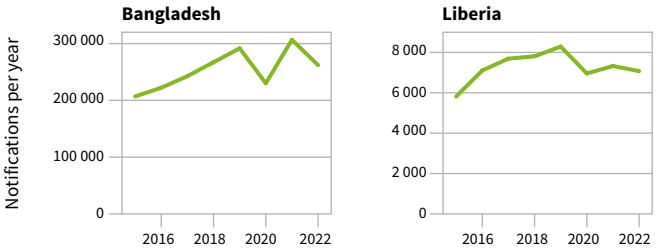
(c) Year-on-year increases in notifications in 2020–2022



(d) No or limited departure from pre-2020 downward trend



(e) Negative impact in 2020,[a] recovery in 2021, decrease in 2022



[a] Countries are shown in descending order of the relative decline (%) between 2019 and 2020, which ranged from 21% to 16%.

(f) No or limited departure from pre-2020 downward trend in 2020 and 2021, but a marked reversal of this trend in 2022

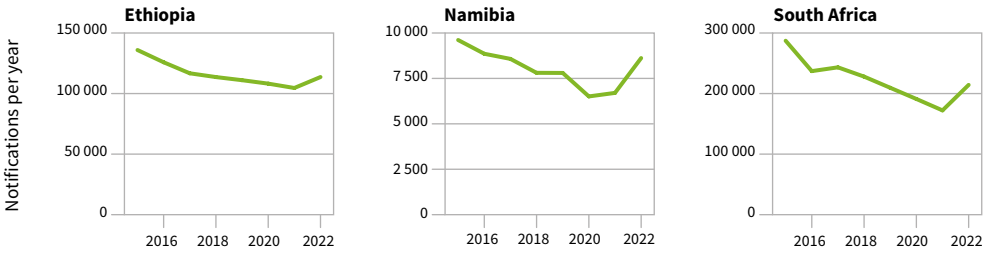
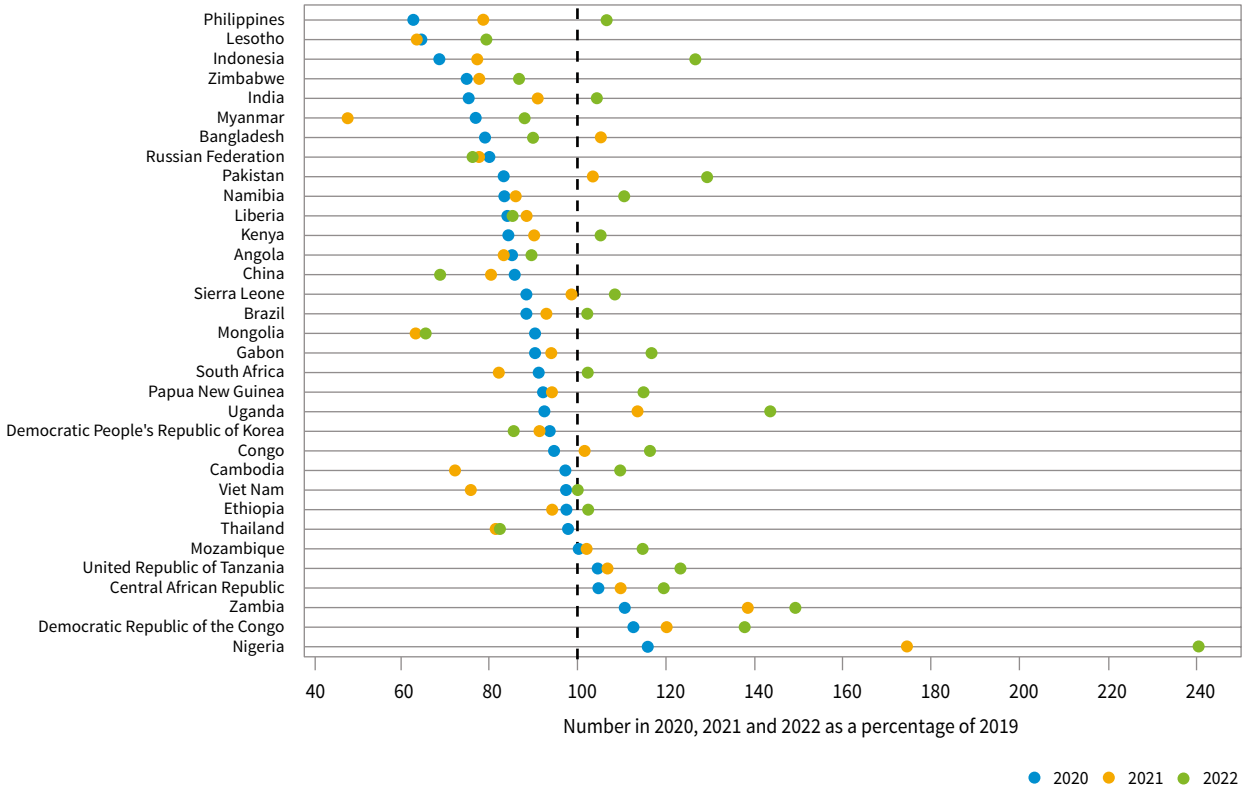


FIG. 4

Case notifications of people newly diagnosed with TB in 2020, 2021 and 2022 compared with 2019, 30 high TB burden and 3 global TB watchlist countries[a]

The vertical dashed line marks the level of 2019.

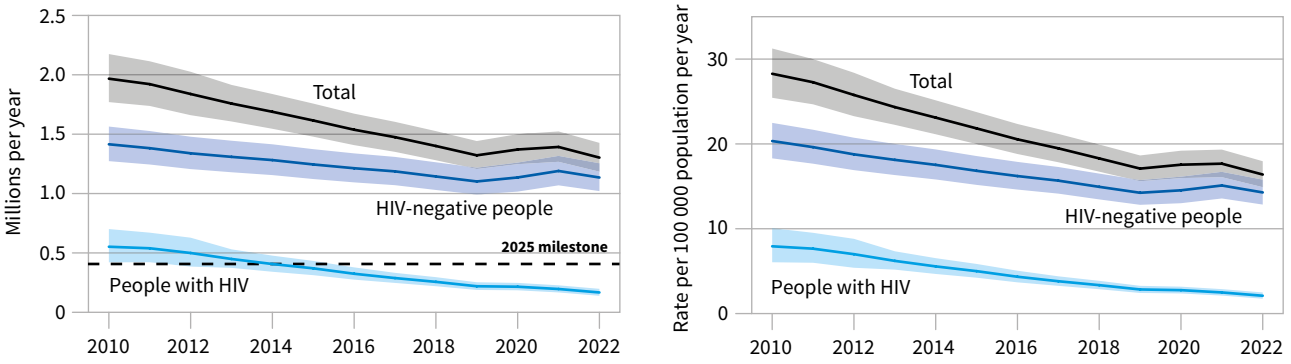


[a] The three global TB watchlist countries are Cambodia, the Russian Federation and Zimbabwe (see **Annex 3** for further explanation).

FIG. 5

Global trends in the estimated number of deaths caused by TB (left) and the TB mortality rate (right),[a] 2010–2022

The horizontal dashed line shows the 2025 milestone of the End TB strategy, which is a 75% reduction in the total number of TB deaths between 2015 and 2025. Shaded areas represent 95% uncertainty intervals.



[a] Deaths from TB among people with HIV are officially classified as deaths caused by HIV/AIDS, with TB as a contributory cause.

infection, the severity of the impact of the pandemic, the extent to which restrictions were put in place and adhered to, the capacity and resilience of health systems, trends in the years leading up to the pandemic, and the extent and intensity of recovery efforts in 2021 and 2022.

Deaths caused by TB

COVID-related increases reversed in 2022

Global reductions in the reported number of people newly diagnosed with TB in 2020 and 2021 suggested that the number of people with undiagnosed and untreated TB had grown, resulting first in an increased number of deaths from TB and more community transmission of infection and then, with some lag-time, increased numbers of people developing TB (**Box 3**).[1] The global recovery in TB case notifications is 2022, to beyond pre-COVID levels, is now estimated to have reversed the upward trend in the number of deaths caused by TB between 2019 and 2021.

Globally in 2022, the total number of deaths caused by TB (including those among people with HIV)[2] was 1.30 million (95% uncertainty interval [UI]: 1.18–1.43 million), down from best estimates of 1.4 million in both 2020 and 2021 and almost back to the level of 2019 (**Fig. 5**).

Global estimates of the number of deaths caused by TB since 2010 have been revised downwards, compared with those published in 2022 *(15)*. The main reason is revisions to estimates for India, based on recently published cause-of-death data for 2014–2019 (**Box 4**).[3]

Global trends in the number of deaths caused by TB differ by HIV status (**Fig. 5**). In 2022, TB caused an estimated 1.13 million deaths among HIV-negative people (95% UI: 1.02–1.26 million), almost back to the level of 2019 after 2 years of estimated increases in 2020 and 2021.[4] Deaths from TB among people with HIV have been falling steadily for many years; in 2022, the estimated number was 167 000 (95% UI: 139 000–198 000).

FIG. 6

Estimated number of excess TB deaths during the COVID-19 pandemic and its aftermath

The **blue** shaded area represents the 95% uncertainty interval of the actual number of deaths estimated to have been caused by TB; the **red** line shows the estimated number of deaths that would have been caused by TB in the absence of the COVID-19 pandemic; the **red** shaded area shows the excess number of deaths caused by TB due to disruptions associated with the COVID-19 pandemic.

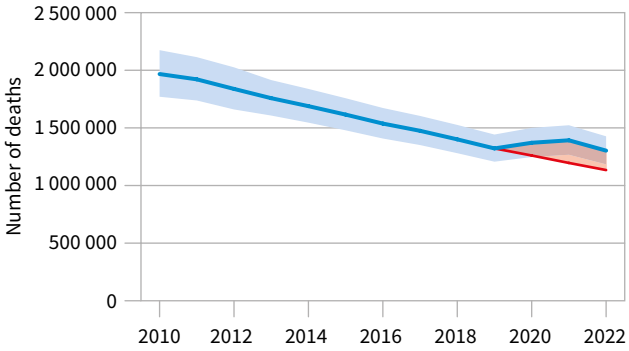
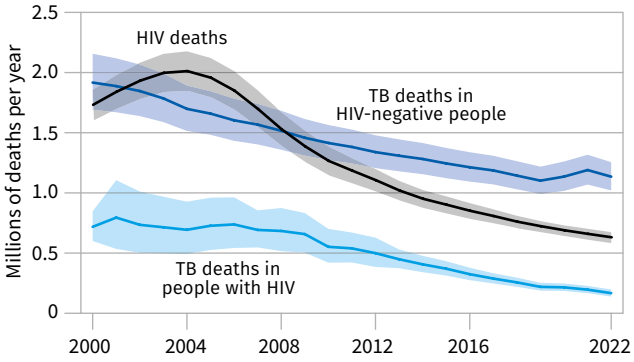


FIG. 7

Global trends in the estimated number of deaths caused by TB and HIV (in millions),[a,b] 2000–2022

Shaded areas represent 95% uncertainty intervals.



[a] For HIV/AIDS, the latest estimates of the number of deaths in 2022 that have been published by UNAIDS are available at http://www.unaids.org/en/ (accessed 15 August 2023). For TB, the estimates for 2022 are those published in this report.

[b] Deaths from TB among people with HIV are officially classified as deaths caused by HIV/AIDS in the International Classification of Diseases.

[1] Disruptions to TB diagnosis and treatment affect those who already have TB disease first; people who remain undiagnosed and untreated have a higher risk of death compared with those started on treatment. Most people infected through increased community transmission will not go on to develop TB disease *(4)*; for those who do, the time between acquisition of infection and development of TB disease ranges from weeks to decades. Disruptions to diagnosis and treatment therefore have a more immediate impact on TB mortality and a more delayed impact on TB incidence. Similarly, recoveries in access to TB diagnosis and treatment have a more immediate effect on TB mortality and a more delayed impact on TB incidence.

[2] Deaths from TB among people with HIV are officially classified as deaths from HIV/AIDS. For this reason, a clear distinction between deaths among HIV-negative people and those among people with HIV is made in **Fig. 5**, **Fig. 6** and **Fig. 7**.

[3] Other updates are explained in **Annex 5**.

[4] The estimated number of deaths caused by TB among HIV-negative people was 1.10 million (95% UI: 0.99–1.22 million) in 2019, 1.14 million (95% UI: 1.02–1.26 million) in 2020 and 1.19 million (95% UI: 1.07–1.32 million) in 2021.

Box 3. Estimating TB incidence and mortality during the COVID-19 pandemic

The most obvious and immediate impact on TB of disruptions caused by the COVID-19 pandemic was a large global fall in the number of people newly diagnosed with TB and reported, in both 2020 and 2021 (**Fig. 1**–**Fig. 4**). In countries where reductions departed from pre-2020 trends, their impact on the numbers of people dying from TB and falling ill with TB was estimated using country- or region-specific dynamic models *(14, 15)*.

The main assumption used in the modelling was that all or most of the reduction in the reported number of people newly diagnosed reflected real reductions in diagnosis (rather than underreporting or a reduction in TB incidence). This results in an increase in the number of people in the community with undiagnosed and untreated TB, which in turn increases the transmission of infection, and subsequently the number of people infected with TB and at risk of developing TB disease.

The most immediate impact on TB disease burden of growing numbers of people with undiagnosed and untreated TB is an increase in the number of deaths from TB. The impact of a consequent increase in transmission on TB incidence (new cases) is more delayed, because of the time lag (from months to many years) between acquisition of infection and progression to TB disease *(4)*. Similarly, the most immediate impact of a recovery in the numbers of people newly diagnosed and treated for TB is a reduction in the number of people dying from TB. Reversals in TB incidence happen with a longer lag-time.

Restrictions during the COVID-19 pandemic (e.g. lockdowns) and adjustments to behaviour (e.g. use of masks) might have reduced TB transmission in 2020 and 2021. The models assumed that transmission was reduced by 50% (UI: 25–75%) during periods of official lockdowns.[a]

In 2023, country-specific dynamic models were used to estimate TB incidence and mortality in the period 2020–2022 for 26 countries that reported large absolute reductions in TB notifications in 2020 or 2021 that departed significantly from pre-2020 trends. The 26 countries were Afghanistan, Angola, Azerbaijan, Bangladesh, Brazil, Cambodia, Colombia, India, Indonesia, Kazakhstan, Kenya, Kyrgyzstan, Lesotho, Malaysia, Mexico, Mongolia, Myanmar, Nepal, Pakistan, Peru, the Philippines, Thailand, Ukraine, Uzbekistan, Viet Nam and Zimbabwe.[b] The models were fitted to monthly or quarterly TB case notification data reported to WHO for the period since January 2020 *(10)* and calibrated to pre-2020 estimates of TB incidence and mortality.[c] Region-specific models were used for 23 other low- and middle-income countries (LMICs) that had reductions in TB notifications in the period 2020–2021 that departed from pre-2020 trends.

Other influential assumptions used in the models, drawing on the scientific literature, include the number of secondary infections per case per year (estimated by model calibration) and the rate of breakdown from TB infection to active TB disease, which was informed by a recent (2018) review of TB models *(4)*.

An important limitation is that the models do not account for the negative impact of the COVID-19 pandemic on broader TB determinants (e.g. undernourishment, poverty and income per capita), which could have influenced both TB incidence and mortality. Impacts on TB incidence and mortality in the modelled countries may thus be underestimated.

The modelling methods have been extensively discussed and reviewed. This included:

- a review by WHO's Strategic and Technical Advisory Group for TB in June 2021 *(17)*;
- a 2-day meeting of a subgroup of the WHO Global Task Force on TB Impact Measurement (the Task Force) in May 2022 *(18)*, which brought together 32 global experts in mathematical modelling, epidemiology and statistics as well as representatives from national TB programmes (NTPs) and partner agencies; and
- in an immediate follow-up to the Task Force meeting, a further detailed review of model documentation by several global experts in TB modelling, following which comments and suggestions were addressed.

From February to June 2023, the models were further informed by a series of in-depth bilateral discussions with 13 countries: Afghanistan, Brazil, Cambodia, Indonesia, Kazakhstan, Kyrgyzstan, Lesotho, Malaysia, Pakistan, the Philippines, Thailand, Uzbekistan and Viet Nam. These discussions were used to identify any new information that could be used to inform model inputs and resulted in some model adjustments (e.g. to the level of underreporting during COVID-19 disruptions).

Further details about the methods used to estimate TB incidence and mortality in the period 2020–2022 (including methods used for non-modelled countries) and the methods used to produce estimates for 2010–2019 are provided in the report webpages (**section 1.1** and **section 1.2**) and a technical appendix.

Estimates in this report are consistent with those published in 2022 *(15)*. In countries with the biggest reductions in TB notifications compared with pre-2020 trends, the estimates show an increase in the number of TB deaths from 2019 to 2020 and again from 2020 to 2021. The pre-COVID decline in TB incidence is estimated to have slowed in 2020, followed by an increase from 2020 to 2021. Also, as suggested by the projections included in the 2021 report *(14)*, the estimates in this report show a further increase in TB incidence in 2022 and a reversal (from a 2021 peak) in the number of deaths caused by TB.

[a] In addition, for India specifically, Google mobility data were used to include a second period of reduced transmission, during the COVID-19 "Delta" wave of 2021 (when there was no official "lockdown"). Such data were not available for other countries.

[b] For four of the modelled countries (Azerbaijan, Brazil, Kazakhstan and Ukraine), national vital registration (VR) data were used for mortality estimates, instead of model-based estimates. For Bangladesh, the estimate of the incidence rate for 2010–2019 (unchanged throughout this period, with considerable uncertainty) was retained for 2020–2022, to avoid an odd discontinuity, and given the absence of evidence about trends in the period 2010–2019.

[c] Generally, these were estimates previously published by WHO, either for 2019 or for a combination of 2014 and 2019. For India, the calibration was to more recent estimates of TB incidence derived from the 2020 national TB prevalence survey and programmatic data, and updated estimates of the number of TB deaths in 2015 and 2019 (**Box 4**).

Box 4. Estimates of the number of deaths caused by TB in India revised downwards

■ WHO estimates of the annual number of deaths caused by TB in India have been revised downwards, following the availability of new cause-of-death data from the country's sample registration system (SRS) for the period 2014–2019. The updated estimates were extensively discussed with the Ministry of Health and Family Welfare in India and also informed by communications with the Institute for Health Metrics and Evaluation (IHME).

The SRS provides data about vital events (births and deaths) that are nationally representative, based on a sample population of about 8 million people. Collection of SRS data on causes of death, based on verbal autopsy, was first piloted in 1998 and then expanded; the initial goal was to cover 1 million deaths between 1998 and 2014 *(19)*. The SRS is an interim solution until the national vital registration (VR) system, which includes medical certification of causes of death, can achieve sufficient national coverage and quality. Coverage of the national VR system ranged from 16 to 22% in the period 2008–2020 *(20)*.

Between February and April 2023, the Office of the Registrar-General and Census Commissioner of India published official reports of SRS cause-of-death data for 2015–2017, 2016–2018 and 2017–2019 *(21–23)*. A report for 2014–2016 was published in May 2022 *(24)*. Reports for 2004–2006, 2007–2009 and 2010–2013 were first published in September 2021 *(25–27)*. Previously, there were no official reports in the public domain that included SRS cause-of-death data.

In 2022, WHO estimates of the number of deaths caused by TB in India for the period 2000–2019 *(15)* were based on those produced as part of IHME's Global Burden of Disease study 2019 (GBD 2019) *(28)*. WHO first used IHME estimates in 2016, in recognition of IHME's access to unpublished SRS datasets (for 2005, 2008 and 2012) and extensive analyses of TB mortality data for India *(29)*. IHME methods include redistribution of causes of death, recognizing challenges in accurate assignment of cause of death based on verbal autopsy.

Estimates of the percentage of total deaths in India that were caused by TB in the official SRS reports are lower than those in GBD 2019, with increasing divergence over time (**Fig. B4.1**). A quasi-binomial model was used to produce a complete time series for 2000–2019, based on the SRS raw values for multi-year time periods (with the raw value assigned to the mid-year). As shown in **Fig. B4.1**, the SRS-based estimates are consistent with the values reported from the national VR system (which has the strength of being based on medical certification of the cause of death rather than verbal autopsy, but the weakness of low national coverage), in terms of absolute values and trends.

Estimates of the total number of deaths caused by TB for each year 2000–2019 were then produced in two steps. First, the SRS-based estimates of the percentage of total deaths caused by TB (shown in the red curve in **Fig. B4.1**) were upward adjusted for all years, to allow for possible inaccuracies in the cause of death assigned using verbal autopsy, and ill-defined causes. The upward adjustment was informed by the values of SRS "raw" data as a proportion of GBD 2019 estimates in the three years for which IHME has unpublished, detailed SRS datasets i.e. 2005, 2008 and 2012. Based on these values, the upward adjustment for all years was approximated as a uniform distribution with bounds of 0.70 and 0.85. The second step was to multiply the upward-adjusted SRS values by WHO estimates of the total number of deaths in India.

The resulting estimates of the number of deaths caused by TB between 2000 and 2019 are considerably lower than the "interim" estimates published in 2022 *(15)*. For example, the revised estimate for 2019 is about 120 000 lower.

Estimates for 2020–2022 were produced using a country-specific dynamic model that accounts for disruptions to TB diagnosis and treatment during the COVID-19 pandemic (**Box 3**), with the model calibrated to the new SRS-based estimates for 2015 and 2019.

The updated estimates of the number of deaths caused by TB in India between 2000 and 2022 are shown in **Fig. B4.2**.

Further details are provided in the online technical appendix.

FIG. B4.1

Estimates of the percentage of deaths in India caused by TB, alternative sources

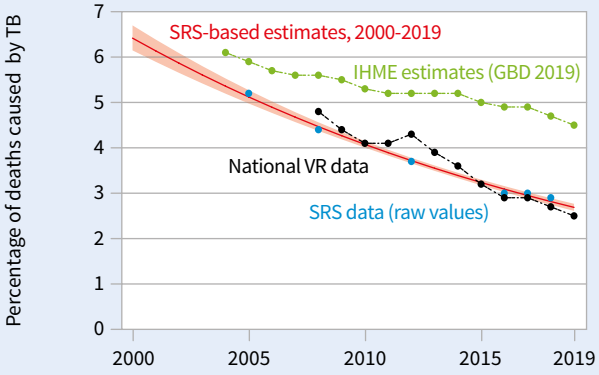


FIG. B4.2

Updated WHO estimates of the number of deaths caused by TB in India, 2000–2022

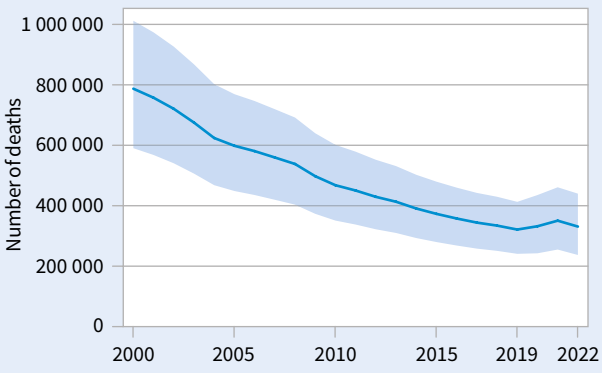
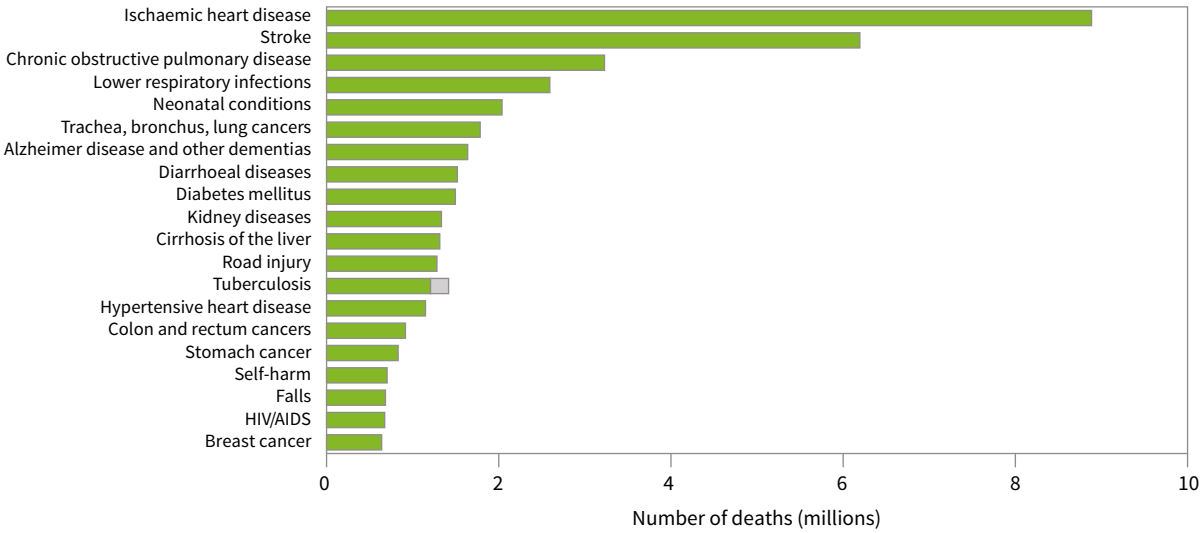


FIG. 8

Top causes of death worldwide in 2019[a,b]

Deaths from TB among people with HIV are shown in grey.



[a] This is the latest year for which estimates for all causes are currently available. See WHO estimates, available at https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death

[b] Deaths from TB among people with HIV are officially classified as deaths caused by HIV/AIDS in the International Classification of Diseases.

COVID-related disruptions are estimated to have resulted in almost half a million excess deaths from TB in the three years 2020–2022,[1] compared with the number that would have occurred if pre-pandemic trends had been maintained (**Fig. 6**).

TB was the world's second leading cause of death from a single infectious agent in 2022, after COVID-19 *(30)*.[2] The global number of deaths officially classified as caused by TB in 2022 (1.13 million) was almost double the number caused by HIV/AIDS (0.63 million), and TB mortality has been much more severely impacted by the COVID-19 pandemic than HIV/AIDS (**Fig. 7**). In contrast to TB, deaths from HIV/AIDS continued to decline between 2019 and 2022 *(31)*.

The latest year for which WHO has published estimates of global deaths by cause is 2019 (**Fig. 8**). In that year, TB was the 13th leading cause of death worldwide and the top cause from a single infectious agent.

The global pattern of a fall in the absolute number of deaths caused by TB (including those among people with HIV) until 2019, followed by increases in 2020–2021 and then a reversal in 2022, was also evident in the WHO Eastern Mediterranean and European regions (**Fig. 9**). In the South-East Asia and Western Pacific regions, the estimated number of deaths caused by TB was relatively stable between 2021 and 2022. In the Region of the Americas, the estimated number of deaths caused by TB continued to rise in 2022. In the African Region, the estimated number of deaths caused by TB fell up to 2019, was stable from 2019 to 2020 and then started to fall again.

Patterns in the 30 high TB burden countries vary; some have estimated reductions in 2022, some have estimated increases and in a few the trend was relatively stable.[3]

In 2022, 81% of the global number of deaths caused by TB among HIV-negative people occurred in the WHO African and South-East Asia regions; India alone accounted for 29% of such deaths. The WHO African and South-East Asia regions also accounted for 81% of the combined total number of deaths caused by TB among people with and without HIV; India accounted for 26% of such deaths.

Of the global number of deaths caused by TB among HIV-negative people in 2022, an estimated 587 000 (95% UI: 528 000–649 000) were adult men (aged ≥15 years) equivalent to 52% of the total; 365 000 (95% UI: 328 000–404 000) were adult women (aged ≥15 years), equivalent to 32% of the total; and 183 000 (95% UI: 164 000–202 000) were children (aged <15 years), equivalent to 16% of the total.

Of the global deaths from TB among people with HIV, an estimated 78 000 (95% UI: 65 000–92 000) were adult men (47% of the total), 58 000 (95% UI: 48 000–69 000) were adult women (35% of the total) and 31 000 (95% UI: 26 000–37 000) were children (18% of the total).

[1] The best estimate is a cumulative total of 475 680 in these 3 years. This is consistent with a previous WHO projection *(16)*.

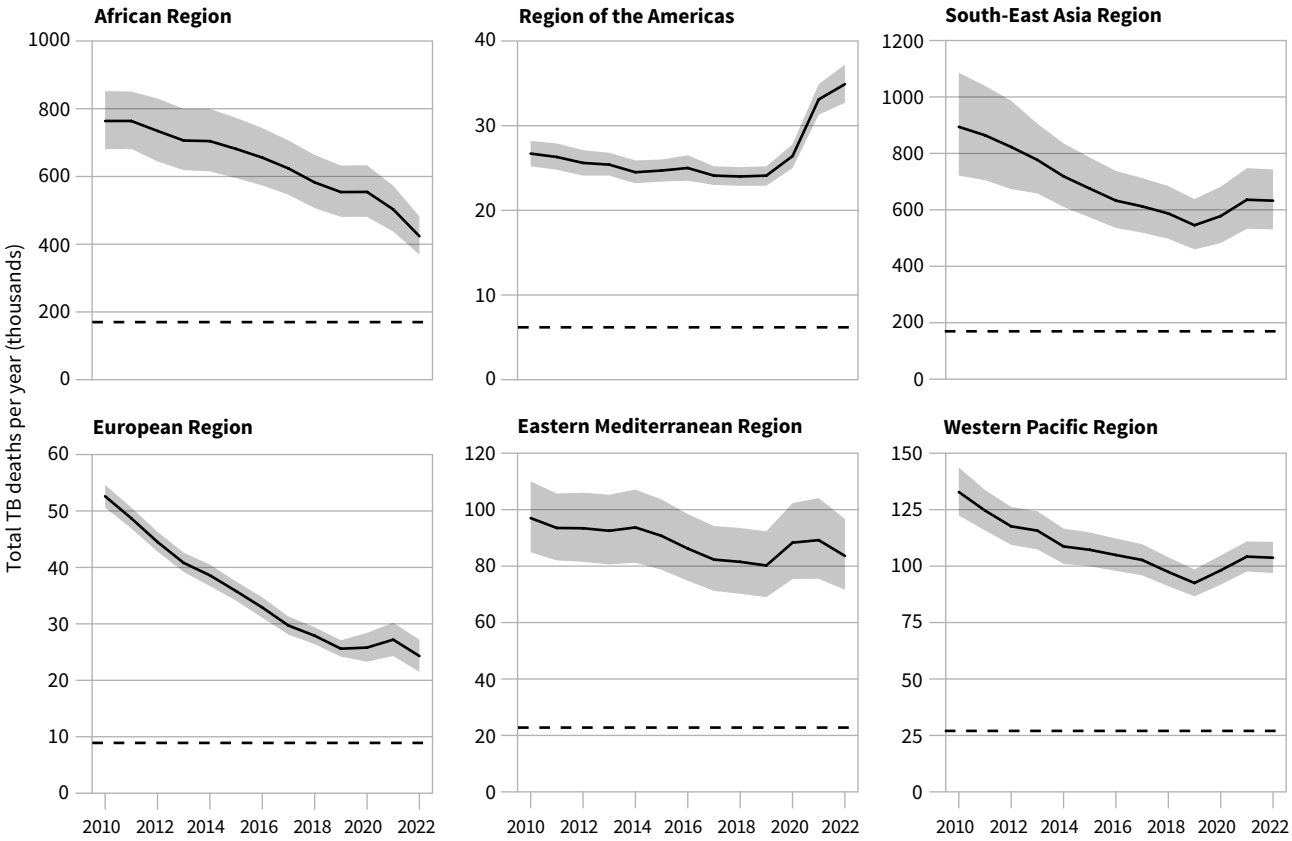
[2] The officially reported number of deaths caused by COVID-19 in 2022 was 1.24 million *(30)*. Since the reported number of deaths does not capture all deaths caused by COVID-19, the actual number was higher.

[3] Time series for each of the 30 high TB burden countries are displayed in the report webpages and mobile app.

FIG. 9

Trends in the estimated absolute number of TB deaths (in thousands, including deaths among people with HIV)[a] by WHO region, 2010–2022

The horizontal dashed line shows the 2025 milestone of the End TB strategy, which is a 75% reduction in the total number of TB deaths between 2015 and 2025. Shaded areas represent 95% uncertainty intervals.



[a] Deaths from TB among people with HIV are officially classified as deaths caused by HIV/AIDS, with TB as a contributory cause.

Number of people developing TB

Global rise continued in 2022

An estimated 10.6 million people (95% UI: 9.9–11.4 million) fell ill with TB worldwide in 2022, up from 10.3 million (95% UI: 9.6–11.0 million) in 2021 and 10.0 million (95% UI: 9.4–10.7 million) in 2020, continuing the reversal of the downward trend that had been sustained for many years up to 2020 (**Fig. 10**).[1,2]

The TB incidence rate (new cases per 100 000 population per year)[3] is estimated to have increased by 3.9% between 2020 and 2022,[4] from 128 (95% UI: 120–137) in 2020 to 133 (95% UI: 124–143) in 2022, following declines of about 2% per year between 2010 and 2020 (**Fig. 10**, right panel).[5]

This reversal of progress made up to 2020 is consistent with previous projections *(14)* and estimates *(15)*, and reflects the estimated impact of disruptions to essential TB services during the COVID-19 pandemic (**Fig. 1**–**Fig. 4**, **Box 3**). The impact of these disruptions on TB incidence globally in 2021 and 2022, compared with a continued decline from 2019 to 2020, can be explained by time lags between increases in TB transmission (caused by more people having undiagnosed and untreated TB) and subsequent development of disease among a proportion of those newly infected.

At regional level, the TB incidence rate continued to increase in 2022 in three of the six WHO regions: the Region of the Americas, South-East Asia and the Western Pacific (**Fig. 11**). An upward trend between 2020 and 2021 was reversed in 2022 in two regions: the Eastern Mediterranean Region (back to the level of 2020) and the

[1] Estimates of TB incidence in 2020 and 2021 have been revised downwards for several countries, compared with those published in 2022 *(15)*, resulting in downward revisions to the global estimates. Further details are provided in **Annex 5**.

[2] The major contributors to the global increase between 2020 and 2022 were Indonesia, Myanmar and the Philippines. Collectively, TB incidence is estimated to have risen by about 0.4 million in these three countries.

[3] The report uses the latest population estimates published by the UN Population Division (see **Annex 2**).

[4] The estimated increase was 1.9% from 2020 to 2021 and also 1.9% from 2021 to 2022.

[5] Globally, the TB incidence rate is estimated to have fallen by 21% between 2010 and 2020.

FIG. 10

Global trends in the estimated number of incident TB cases (left) and the incidence rate (right), 2010–2022

The horizontal dashed line shows the 2025 milestone of the End TB strategy, which is a 50% reduction in the TB incidence rate between 2015 and 2025. Shaded areas represent 95% uncertainty intervals.

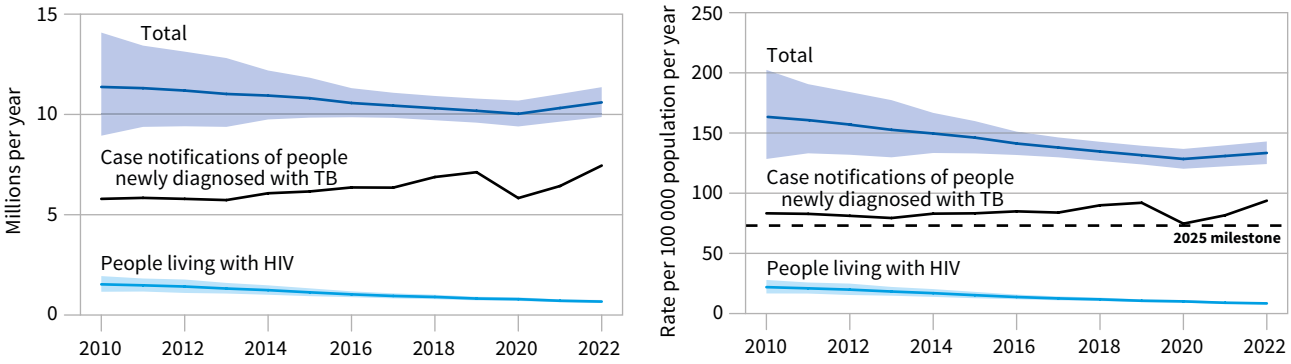


FIG. 11

Trends in estimated TB incidence rates by WHO region, 2010–2022

The overall TB incidence rate is shown in **blue** and the incidence rate among people living with HIV is shown in **light blue**. The **black** solid lines show case notifications of people newly diagnosed with TB, for comparison with estimates of the overall incidence rate. The horizontal dashed line shows the 2025 milestone of the End TB strategy, which is a 50% reduction in the TB incidence rate between 2015 and 2025. Shaded areas represent 95% uncertainty intervals.

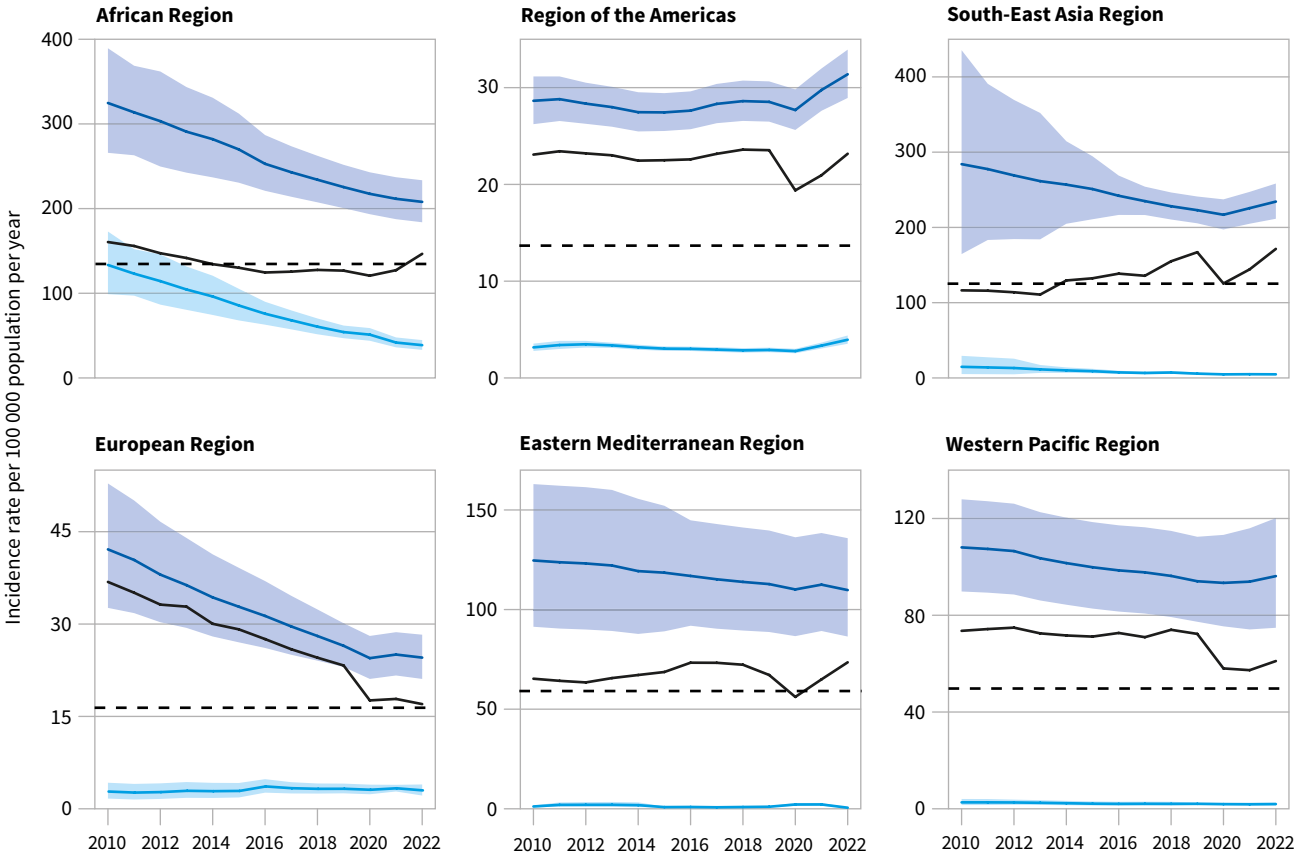
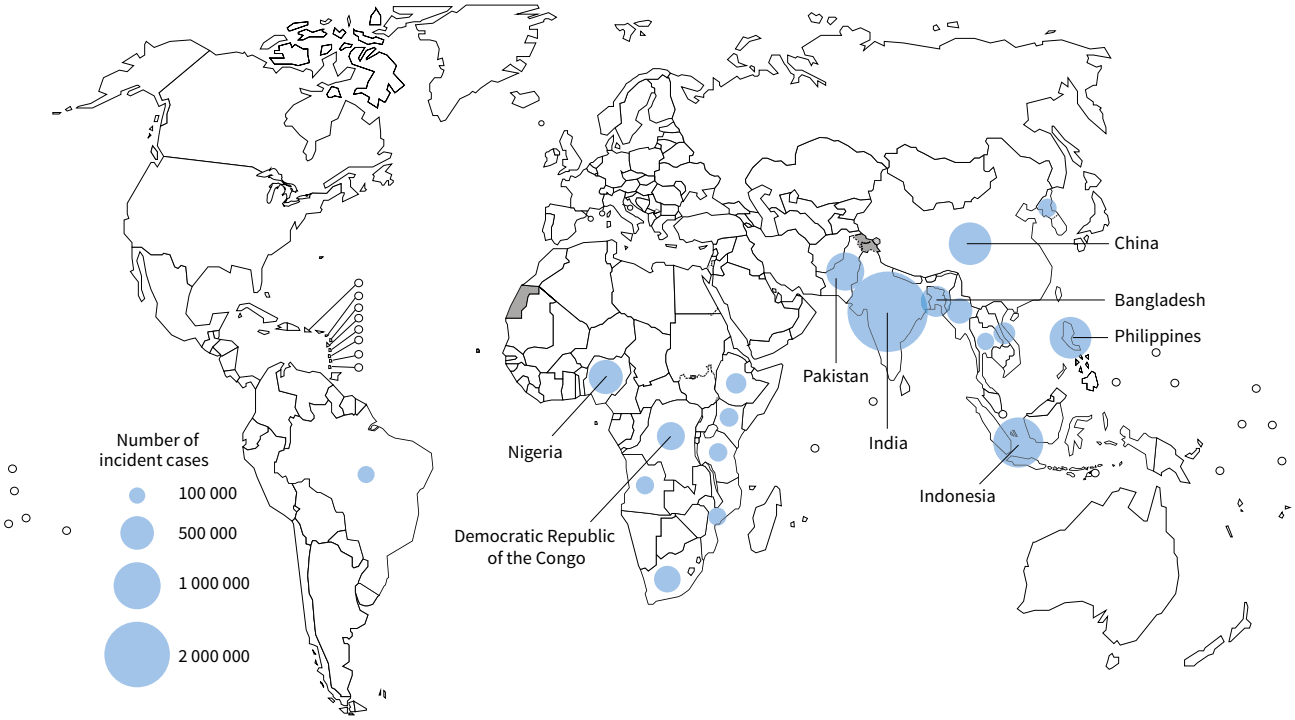


FIG. 12

Estimated number of incident TB cases in 2022, for countries with at least 100 000 incident cases[a]



[a] The eight countries ranked in order from first to last in terms of numbers of cases, and that accounted for about two thirds of global cases in 2022, are India, Indonesia, China, the Philippines, Pakistan, Nigeria, Bangladesh and the Democratic Republic of the Congo.

European Region (almost back to the level of 2020). In the African Region, the decline that has been sustained for many years was maintained in 2022, consistent with evidence that disruptions related to the COVID-19 pandemic had limited impact on the number of people diagnosed and officially notified with TB in either 2020 or 2021 (**Fig. 2**).

Geographically, in 2022, most people who developed TB were in the WHO regions of South-East Asia (46%), Africa (23%) and the Western Pacific (18%), with smaller proportions in the Eastern Mediterranean (8.1%), the Americas (3.1%) and Europe (2.2%). The 30 high TB burden countries accounted for 87% of all estimated incident cases worldwide, and eight of these countries (**Fig. 12**) accounted for more than two thirds of the global total: India (27%), Indonesia (10%), China (7.1%), the Philippines (7.0%), Pakistan (5.7%), Nigeria (4.5%), Bangladesh (3.6%) and the Democratic Republic of the Congo (3.0%).

TB can affect anyone, regardless of age or sex (**Fig. 13**). The highest burden is in adult men (aged ≥15 years), with an estimated 5.8 million cases (95% UI: 5.4–6.2 million) in 2022, equivalent to 55% of the estimated total. There were an estimated 3.5 million cases (95% UI: 3.3–3.8 million) among adult women (aged ≥15 years), equivalent to 33% of the estimated total; and 1.3 million cases (95% UI: 1.2–1.3 million) among children (aged 0–14 years), equivalent to 12% of the estimated

FIG. 13

Global estimates of TB incidence (black outline) and case notifications of people newly diagnosed with TB disaggregated by age and sex (female in purple; male in orange), 2022

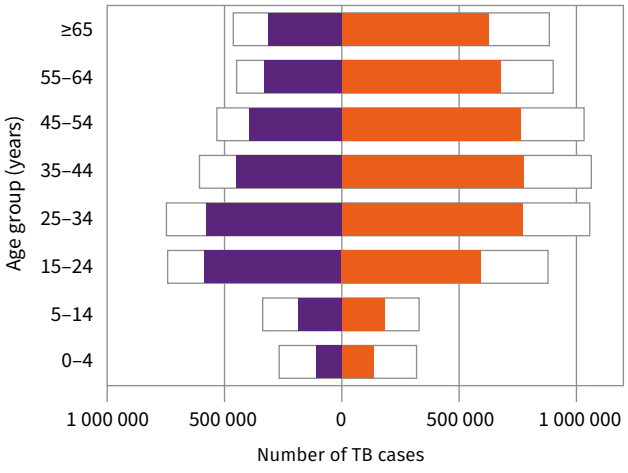
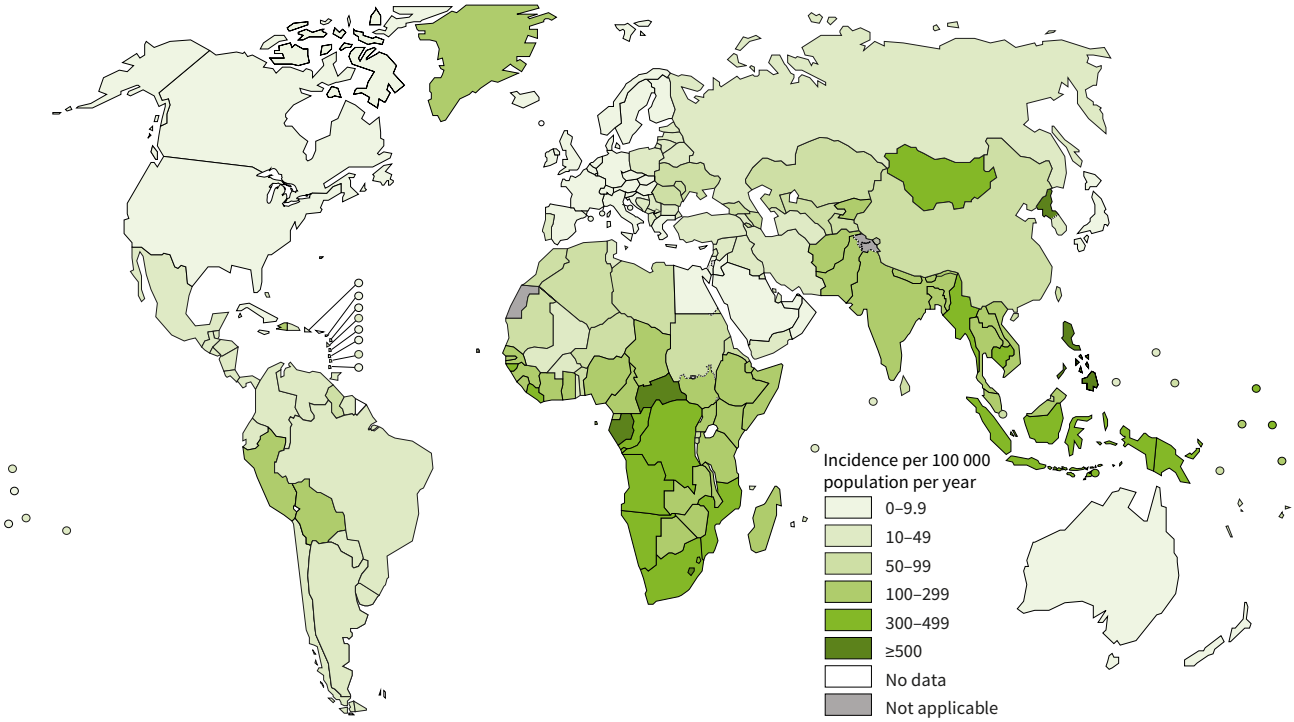


FIG. 14

Estimated TB incidence rates, 2022



total. The higher share of TB cases among men is consistent with evidence from national TB prevalence surveys, which show that TB disease affects men more than women, and that gaps in case detection and reporting are higher among men.[1]

Among all incident cases of TB in 2022, 6.3% were people living with HIV; this proportion has been steadily declining for several years. The proportion of people with a new episode of TB who were living with HIV was highest in countries in the WHO African Region, exceeding 50% in parts of southern Africa.

The severity of national TB epidemics, in terms of the number of incident TB cases per 100 000 population per year, varies widely among countries, from less than 10 to more than 500 new and relapse cases per 100 000 population per year (**Fig. 14**). In 2022, 57 countries had a low incidence of TB (<10 cases per 100 000 population per year), mostly in the WHO Region of the Americas and the WHO European Region, plus a few countries in the WHO Eastern Mediterranean and Western Pacific regions. There were 150–400 cases per 100 000 population in most of the 30 high TB burden countries, and more than 500 cases per 100 000 population in the Central African Republic, the Democratic People's Republic of Korea, Gabon, Lesotho and the Philippines.

Drug-resistant TB continues to be a public health threat. Resistance to rifampicin – the most effective first-line drug – is of greatest concern. TB that is resistant to rifampicin and isoniazid is defined as multidrug-resistant TB (MDR-TB). Both MDR-TB and rifampicin-resistant TB (RR-TB) require treatment with second-line drugs.

Globally, the estimated annual number of people who developed MDR-TB or RR-TB (MDR/RR-TB) was relatively flat between 2020 and 2022 (**Fig. 15**), after a slow downward trend between 2015 and 2019. The estimated number in 2022 was 410 000 (95% UI: 370 000–450 000).[2] The reason why the number of people developing MDR/RR-TB was relatively stable from 2020–2022, in contrast to an estimated rise in the number of people developing TB overall (**Fig. 10**), is that increases in the overall number of people developing TB have been compensated for by an estimated downward trend (since 2015) in the proportion of people with TB who have MDR/RR-TB, particularly among those with a previous history of treatment (**Fig. 16**).

In 2022, the estimated proportion of people with TB who had MDR/RR-TB was 3.3% (95% UI: 2.6–4.0%) among new cases and 17% (95% UI: 11–23%) among those previously treated; the figures in 2015 were 4.0% (95% UI: 3.1–4.9%) and 25% (95% UI: 15–36%), respec-

[1] For further details, see Section 1.4 of the report webpages.

[2] Estimates for 2015–2021 are lower than those published in 2022 *(15)*, although with widely overlapping uncertainty intervals. Estimates for the entire period 2015–2022 have been revised based on new or updated data (including corrections to data previously reported to WHO). The country revision that had the biggest impact on global estimates was for Pakistan. Further details are provided in **Annex 5** and the online technical appendix.

FIG. 15

Global trend in the estimated number of people who developed MDR/RR-TB (incident cases), 2015–2022

The shaded area represents the 95% uncertainty interval.

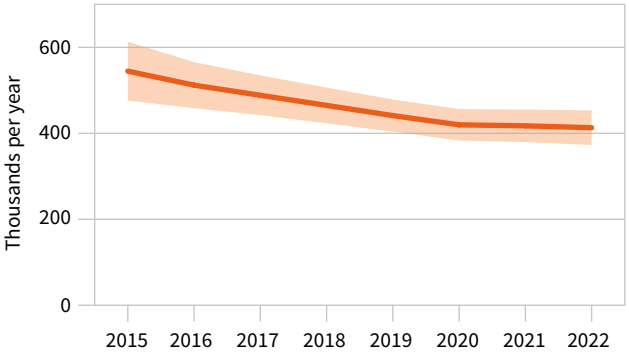
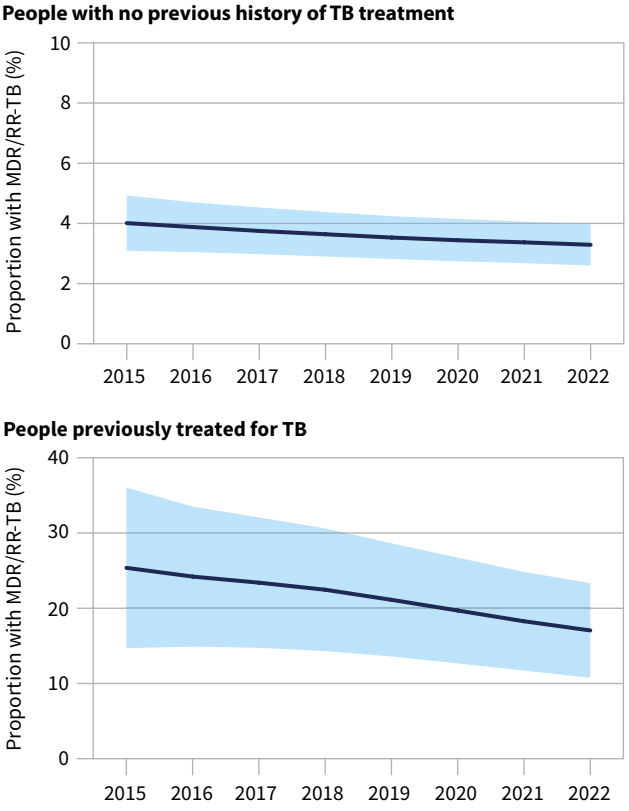


FIG. 16

Global trend in the estimated percentage of people with TB who had MDR/RR-TB, 2015–2022

The shaded areas represent 95% uncertainty intervals.



tively; in 2020, the figures were 3.4% (95% UI: 2.7–4.1%) and 20% (95% UI: 13–27%), respectively (**Fig. 16**).

Three countries accounted for 42% of the estimated global number of people who developed MDR/RR-TB in 2022 (**Fig. 17**): India (27%), the Philippines (7.5%) and the Russian Federation (7.5%). The highest proportions (>50% of previously treated cases with MDR/RR-TB) are found in the Russian Federation and in several countries in Eastern Europe and Central Asia.

Milestones for reducing TB disease burden

Mostly off track, some success stories

The first End TB Strategy milestones for reductions in TB disease burden were a 35% reduction in the total number of deaths caused by TB (including those among people with HIV[1]) and a 20% reduction in the TB incidence rate by 2020, compared with levels in 2015; the second milestones, for 2025, were a 75% reduction in deaths from TB and a 50% reduction in TB incidence (**Box 2**). The first milestones set for 2020 have not yet been reached either globally or in most WHO regions and countries, and the second milestones are far away in most parts of the world. Reversals of progress during the COVID-19 pandemic have made both milestones much harder to achieve.

Globally, the net reduction in the total number of deaths caused by TB between 2015 and 2022 was 19%. Progress achieved up to 2019 (a 19% reduction from 2015 to 2019 and a 33% reduction from 2010 to 2019) was compromised by increases in the number of deaths caused by TB in 2020 and 2021 (**Fig. 5**, left panel).

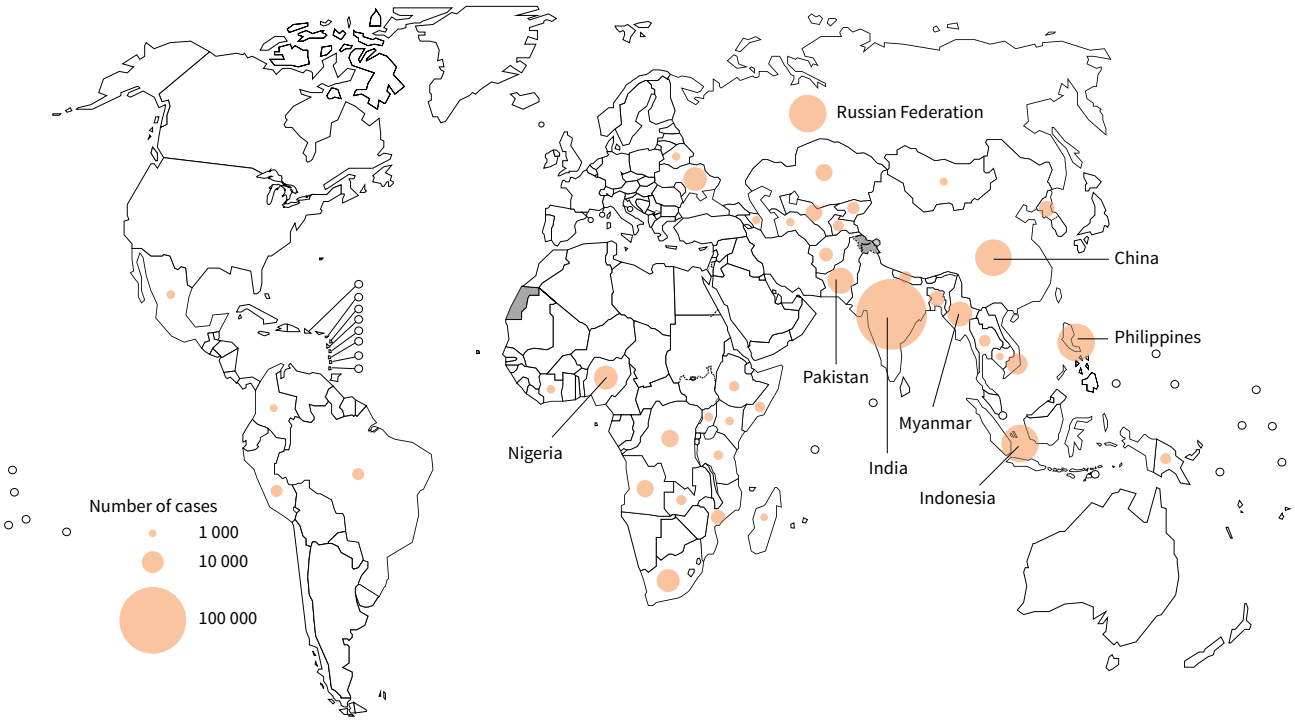
At regional level, reductions in the number of deaths caused by TB since 2015 vary (**Fig. 9**). The biggest reductions were in the WHO African Region, with a 38% decline by 2022, followed by the WHO European Region with a decline of 32%. These two regions are the only ones that have surpassed the first milestone of the End TB Strategy. Following major reversals of progress in 2020 and 2021, the net decline by 2022 compared with 2015 was modest in three WHO regions: the Eastern Mediterranean (7.8%), South-East Asia (6.3%) and the Western Pacific (3.3%). In the Region of the Americas, the estimated number of deaths caused by TB in 2022 was much higher than in 2015 (+41%).

Progress in reducing the number of deaths caused by TB at country level is highly variable (**Fig. 18**). By 2022, a total of 47 countries had reached or surpassed the first milestone of the End TB Strategy, with an estimated reduction of at least 35% since 2015. This included at least one country in every WHO region. Some countries are estimated to have achieved reductions of 50% or more between 2015 and 2022, including five high TB burden countries (Kenya, Mozambique, Uganda, the

[1] Officially classified as deaths from HIV/AIDS, with TB as a contributory cause.

FIG. 17

Estimated number of people who developed MDR/RR-TB (incident cases) in 2022, for countries with at least 1000 incident cases[a]



[a] The eight countries ranked in descending order of the total number of RR-TB incident cases in 2022 are India, the Philippines, the Russian Federation, Indonesia, China, Pakistan, Myanmar and Nigeria.

United Republic of Tanzania and Zambia) and one of the three global TB watchlist countries (the Russian Federation).[1] At the other extreme, there are 71 countries where the number of deaths caused by TB in 2022 was more than 5% above the level of 2015, most noticeably in the WHO Region of the Americas.

Globally, the cumulative reduction in the TB incidence rate from 2015 to 2022 was 8.7%, far from the End TB Strategy milestone of a 50% reduction by 2025 (**Fig. 10**, right panel).

At regional level, as with reductions in deaths caused by TB, reductions in the TB incidence rate since 2015 vary (**Fig. 11**). The biggest reduction was in the WHO European Region, with a net reduction of 25% by 2022, even though progress was reversed by COVID-related disruptions in 2021 and the incidence rate remained above the 2019 level in 2022. A similar reduction was achieved in the African Region, with a 23% decline by 2022. These are the only regions to have surpassed the first milestone of the End TB Strategy. The net decline by 2022 compared with 2015 was relatively small in three of the remaining WHO regions: the Eastern Mediterranean Region (7.4%), South-East Asia (6.6%) and the Western Pacific (3.7%). Increases in TB incidence in 2021 and 2022 in the WHO South-East Asia and Western Pacific regions were a major setback to progress made up to 2019, while the WHO Eastern Mediterranean Region suffered a setback in 2020 that was reversed in 2022. The most concerning trend is in the WHO Region of the Americas, where there was a net increase of 14% between 2015 and 2022.

Progress in reducing the TB incidence rate at country level is highly variable (**Fig. 19**). By 2022, a total of 83 countries, mostly in the WHO European and African regions, had achieved estimated reductions of more than 20% since 2015, thus surpassing the first milestone of the End TB Strategy. A total of 21 countries are estimated to have achieved reductions of at least 50% between 2015 and 2022, including one high TB burden country (South Africa). At the other extreme, there are 39 countries where TB incidence in 2022 was estimated to be more than 5% higher than in 2015. These are most noticeably in the WHO Region of the Americas, but also include four high TB burden countries in Asia: Indonesia, Mongolia, Myanmar and the Philippines.

[1] Alongside the list of 30 high TB burden countries for 2021–2025, WHO established a global TB watchlist (**Annex 3**). The watchlist comprises the three countries that transitioned out of the previous list for 2016–2020, which warrant continued global attention: Cambodia, the Russian Federation and Zimbabwe.

FIG. 18

Change (%) in the estimated number of deaths caused by TB, 2022 compared with 2015

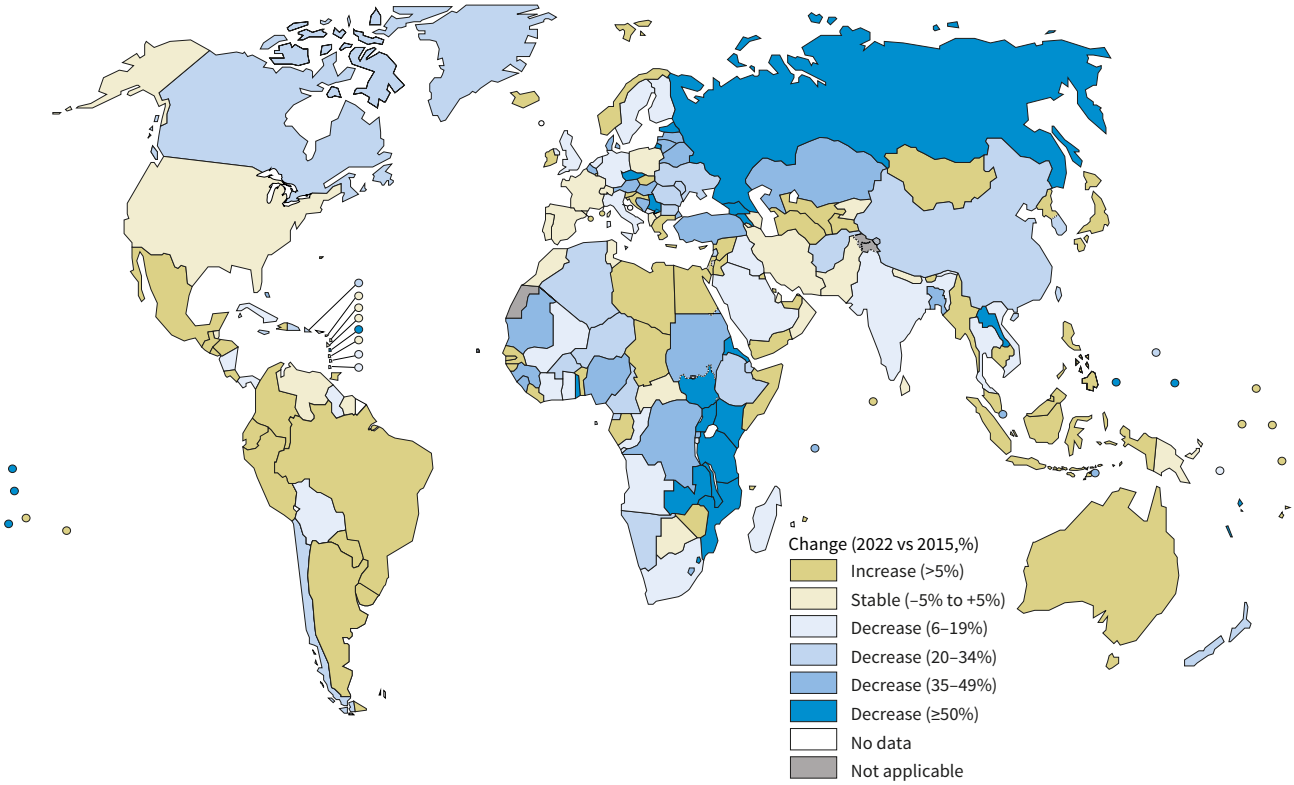


FIG. 19

Change (%) in estimated TB incidence (new cases per 100 000 population), 2022 compared with 2015

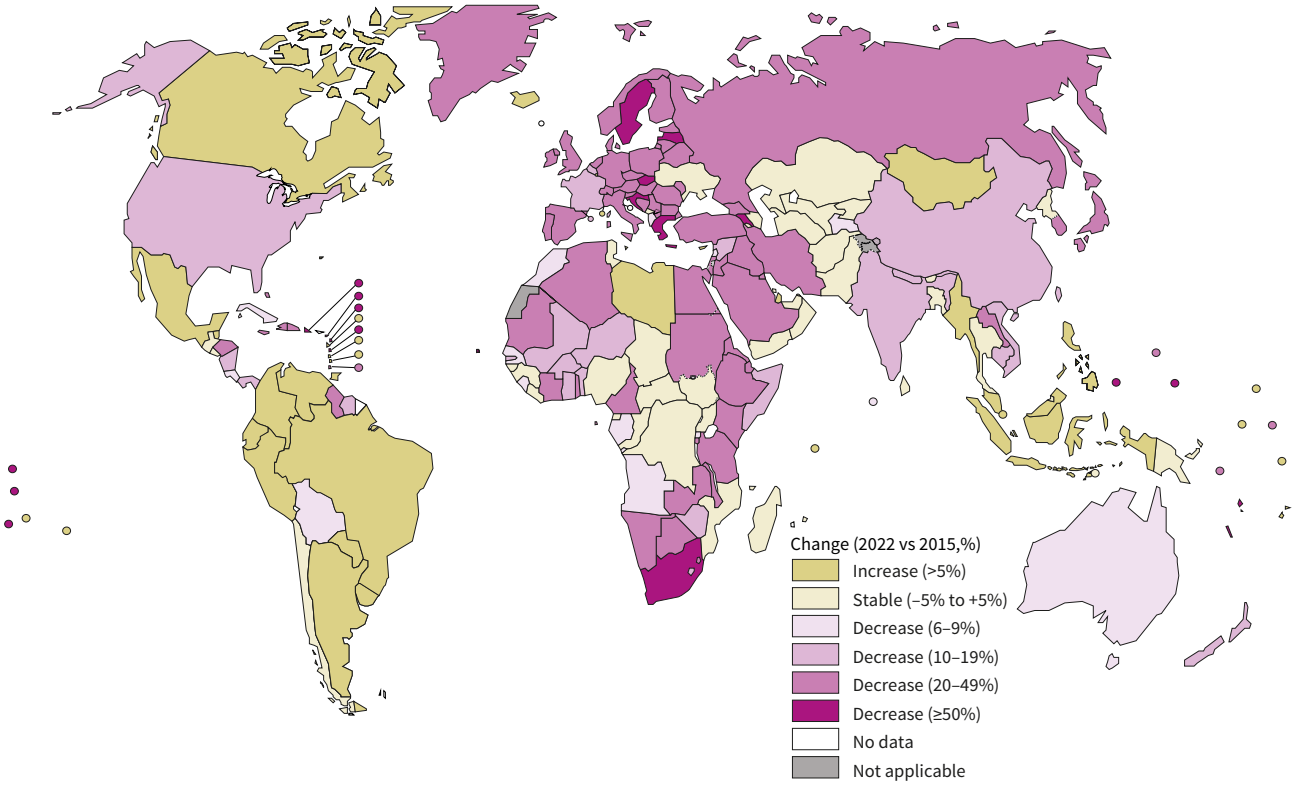
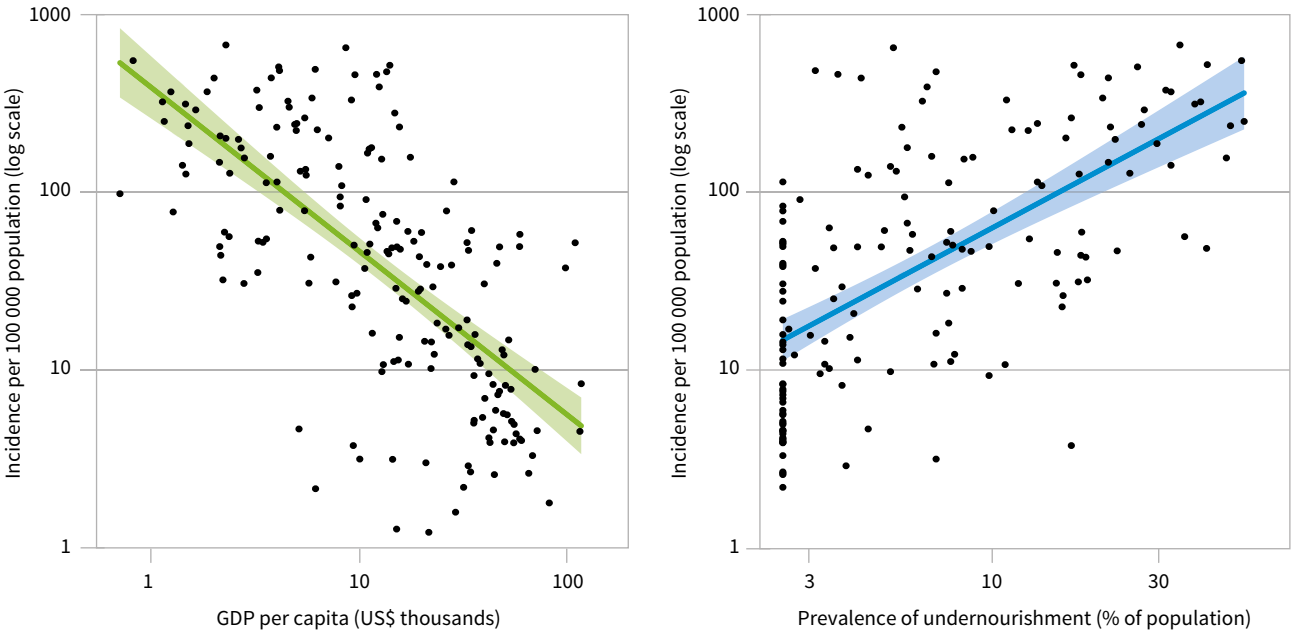


FIG. 20

The relationship between GDP per capita and the prevalence of undernourishment,[a] and TB incidence per 100 000 population, 2022[b]



[a] Prevalence of undernourishment is the percentage of the population whose habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and healthy life.

[b] The year of data used for GDP per capita and undernourishment is the latest year for which data are available in the World Bank (https://data.worldbank.org) and SDG (https://unstats.un.org/sdgs/dataportal) databases, respectively.

TB deaths and incidence beyond 2022

Global rise in incidence may reverse in 2023 or 2024

The country-specific models developed for 26 countries (**Box 3**) to estimate TB incidence and mortality in the period 2020–2022 also allow projections for subsequent years, for different scenarios of recovery in the numbers of people newly diagnosed and treated for TB in the period 2023–2025. If the recoveries in 2022 are sustained, then at the global level the number of deaths caused by TB should continue to decline. Reversal of the upward trend in TB incidence may occur in 2023 but could take until 2024.

At country level, returning to pre-COVID downward trends is most challenging in the countries that experienced the biggest reductions in the number of people newly diagnosed and treated for TB in 2020 and 2021; of these, the two that have the biggest influence on global trends are Indonesia and the Philippines. Both countries achieved impressive recoveries in 2022, which have already moderated upward trends in the number of people developing TB and the number of deaths caused by TB. Maintaining these recoveries should be a top priority in both countries, and elsewhere, in 2023 and beyond.

The current models might understate the impact of the COVID-19 pandemic on TB disease burden in 2020–2022, because they do not account for negative effects on broader TB determinants (**Box 3**). These include average income (measured as gross domestic product [GDP] per capita) and the prevalence of undernourishment, both of which are closely associated with TB incidence (**Fig. 20**). Worsening trends in these two indicators, and other determinants such as levels of poverty, could increase the probability of developing TB disease among people already infected with *M. tuberculosis* as well as their subsequent risk of dying from TB. Declines in income may also affect health care seeking behaviour when people become unwell, making delays in TB diagnosis and treatment more likely.

Estimation of TB disease burden

New direct measurements needed

Estimating TB disease burden during the COVID-19 pandemic and its aftermath is difficult and currently relies on country- and region-specific dynamic models for many low and middle-income countries (LMICs) (**Box 3**). This is in contrast to the methods used for the period 2000–2019.[1] These included use of results from population-based surveys of the prevalence of TB disease that were implemented between 2000 and 2019 to inform estimates of TB incidence in 29 countries that accounted for about two-thirds of global TB incidence; and use

[1] For further details, see Section 1.1 and Section 1.2 of the report webpages.

of data from national vital registration (VR) systems or mortality surveys for the period 2000–2019 to inform estimates of the number of deaths caused by TB in 123 countries that accounted for about 60% of the global number of deaths caused by TB among HIV-negative people.

For this report, there were only three high TB burden or global TB watchlist countries for which data on the number of TB deaths in the period 2020–2022 were available from national VR systems and shared with WHO: Brazil, China and the Russian Federation. Among the modelled countries, in addition to Brazil, national VR data were used to produce the mortality estimates for Azerbaijan, Kazakhstan and Ukraine (**Box 3**).[1]

The only country in which a national TB prevalence survey has been completed since 2019 is India; the survey was started in 2019, interrupted for several months in 2020 and then completed in 2021. Results from this survey were a key input to the estimates of TB incidence in India published in this report.[2]

New national population-based surveys of TB disease and up-to-date cause-of-death data from national or sample VR systems of high quality and coverage are needed for more accurate estimation in the wake of the pandemic. Inventory studies to assess the level of underreporting of people diagnosed with TB would also be helpful.

A repeat national TB prevalence survey in Cambodia started in July 2023 (following previous surveys in 2002 and 2011) and 11 additional countries are actively interested in implementing a repeat survey in the next 1–3 years: Ethiopia, Ghana, Indonesia, Malawi, Nigeria, Pakistan, Thailand, Uganda, the United Republic of Tanzania, Zambia and Zimbabwe.[3] In Indonesia, a national inventory study is also being planned, to be implemented before the repeat national TB prevalence survey.

The recently published cause-of death data from the sample registration system (SRS) in India (**Box 4**) clearly demonstrate the value of up-to-date cause of death data from sample and national VR systems, for more reliable tracking of trends in the number of deaths caused by TB.

TB diagnosis and treatment

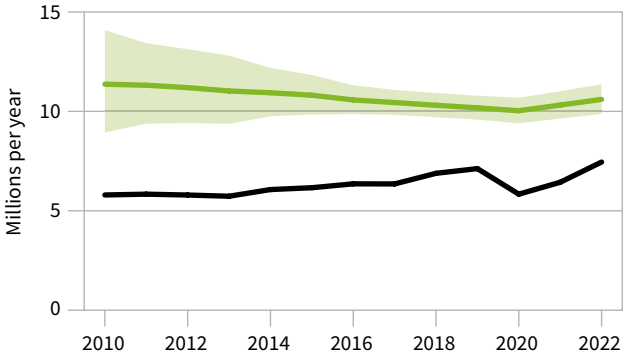
Global recovery in 2022, but targets not achieved

There are still wide gaps between the estimated number of people who develop TB each year (incident cases) and the number of people newly diagnosed and officially reported as a TB case (**Fig. 21**), reflecting a mixture of underdiagnosis of people with TB as well as underreporting of people diagnosed with TB to national authorities (**Fig. 21**). Disruptions associated with the COVID-19 pandemic caused a major widening of the global gap in 2020 and 2021, to best estimates of around 4 million in both years. The major rebound in global notifications of people newly diagnosed with TB in 2022 (**Fig. 1**) has narrowed the gap back to the pre-pandemic level, with best estimates of 3.1 million in both 2019 and 2022. However, it is important to highlight that some of the rebound in the number of people newly diagnosed with TB and reported as a "new case" in 2021 and 2022 probably reflects a sizeable backlog of people who developed TB in previous years; they were not "incident cases", but rather people whose diagnosis was delayed by COVID-related disruptions.

FIG. 21

Global trend in case notifications of people newly diagnosed with TB (black) and the estimated number of incident TB cases (green), 2010–2022

The shaded area represents the 95% uncertainty interval.



The two countries that made the biggest contributions to the global rebound in the reported number of people newly diagnosed with TB in 2022 were India and Indonesia, together accounting for 56% of the increase between 2021 and 2022. Previously, they were also the main contributors to the large global increase in TB case notifications that occurred between 2013 and 2019. The two other countries that made major contributions to the global increase between 2021 and 2022 were the Philippines and Pakistan (11% and 8.4% of the global increase, respectively).

In 2022, TB treatment coverage (approximated as the reported number of people newly diagnosed with TB divided by incidence)[4] appears to have recovered to the pre-pandemic level of 70% (95% UI: 66–75%), up from 62% (95% UI: 58–67%) in 2021 and 58% (95% UI: 55–62%) in 2020. However, as already highlighted above, some of the people newly diagnosed with TB in 2022 (and 2021)

[1] i.e. the models were used only for estimates of TB incidence in these countries.

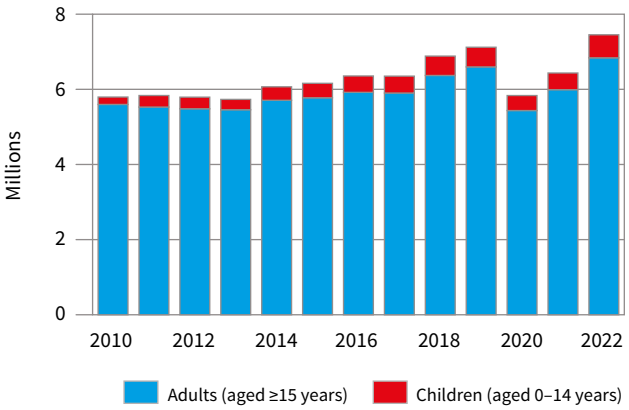
[2] Further details are provided in **Annex 5** and the online technical appendix.

[3] For further details, see Section 1.4 of the report webpages.

[4] Some people who are newly diagnosed and reported may not be started on treatment, and some people may be diagnosed and treated but not reported (and thus not included in the number of case notifications).

FIG. 22

The global number of people reported to have been treated for TB disease, 2010–2022



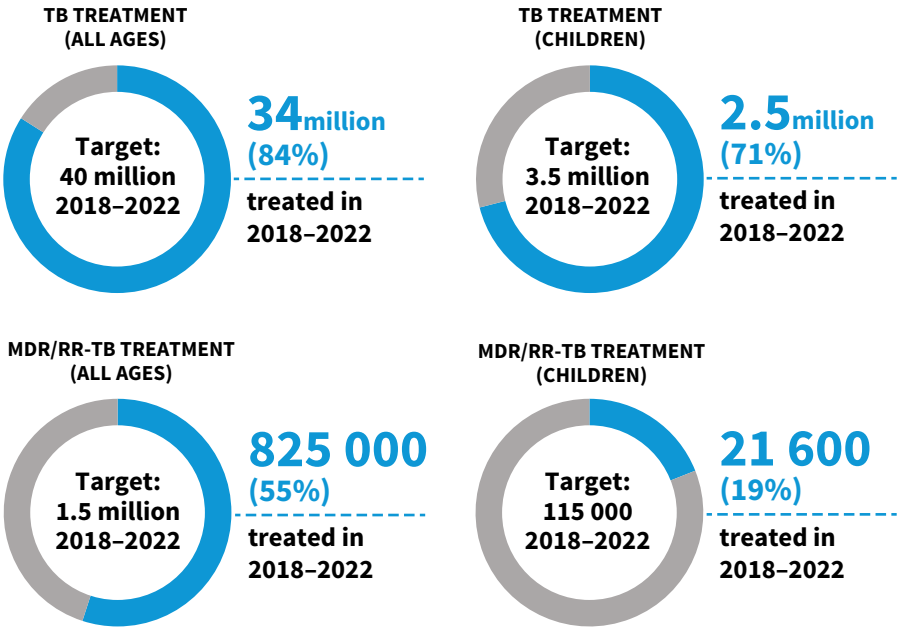
tral African Republic, Lesotho, Liberia, Mongolia and Myanmar.

The major reversals of progress in increasing the number of people newly diagnosed with TB each year (**Fig. 1**) in 2020 and 2021 badly impacted progress towards global TB treatment targets (**Fig. 22**). Despite the global recovery in 2022, none of the treatment targets set for the period 2018–2022 at the first UN high-level meeting on TB were achieved (**Fig. 23**). The cumulative number of people treated for TB between 2018 and 2022 was 34 million,[1] equivalent to 84% of the 5-year (2018–2022) target of 40 million. This number included 2.5 million children, 71% of the 5-year target of 3.5 million.

In 2022, 10 countries collectively accounted for 71% of the global gap between estimated TB incidence and the reported number of people newly diagnosed with

FIG. 23

The global numbers of people treated for TB between 2018 and 2022, compared with targets set at the 2018 UN high-level meeting on TB



were part of a backlog of people who developed TB in previous years (and were thus not "incident" cases), whose diagnosis was delayed by COVID-related disruptions. This distorts estimates of treatment coverage in 2021 and 2022.

Among the six WHO regions, best estimates of treatment coverage in 2022 ranged from 63% in the Western Pacific Region to 74% in the Region of the Americas. Of the 30 high TB burden countries, those with the highest levels (≥80%) of treatment coverage in 2022 included Brazil, India, Uganda and Zambia. Five high TB burden countries had worryingly low levels of treatment coverage in 2022, with best estimates of below 50%: the Central African Republic, Lesotho, Liberia, Mongolia and Myanmar.

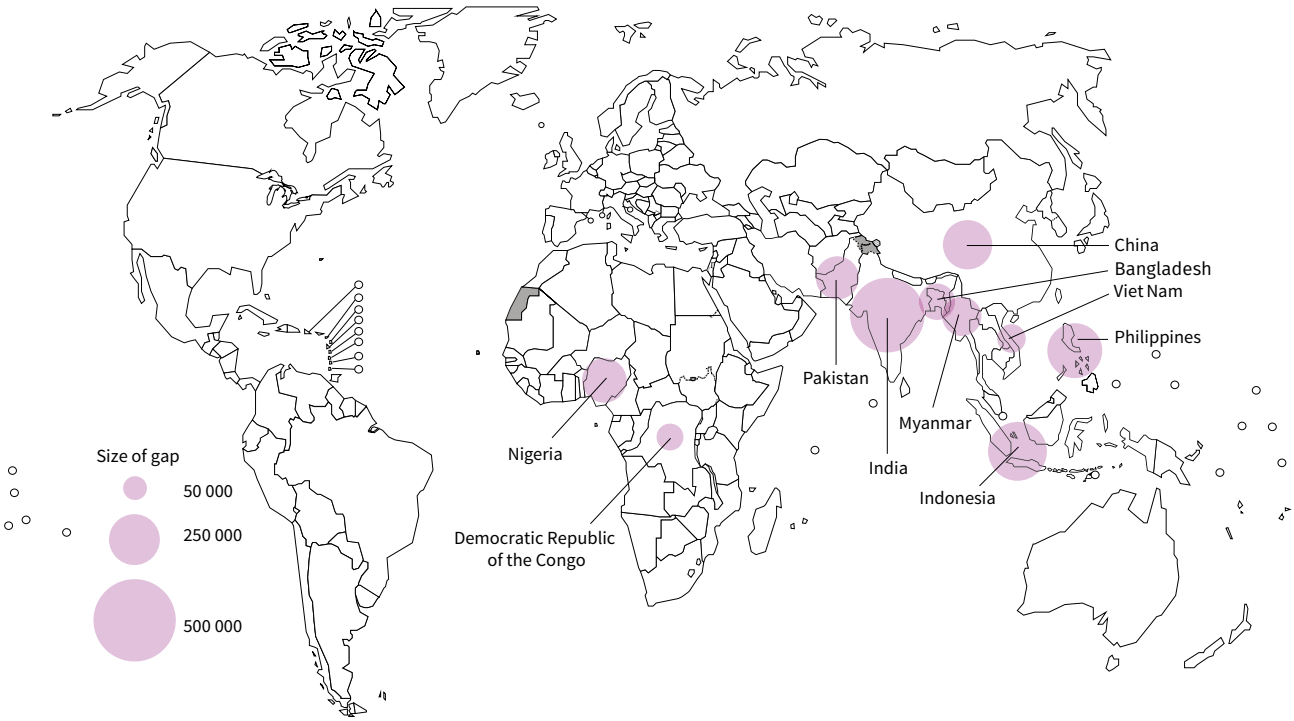
TB (**Fig. 24**). The top five contributors (collectively accounting for more than 50% of the global gap) were India (18%), Indonesia (11%), the Philippines (9.6%), Nigeria (6.2%) and Pakistan (5.8%). From a global perspective, efforts to increase levels of case detection are of particular importance in these countries.

In many countries, there is also a need to increase the percentage of cases confirmed bacteriologically by scaling up the use of recommended diagnostics, in line with

[1] This number assumes that all those diagnosed and reported were treated.

FIG. 24

The ten countries with the largest gaps between notifications of people with a new or relapse episode of TB and the best estimates of TB incidence,[a] 2022



[a] The ten countries ranked in order of the size of the gap between notified cases and the best estimates of TB incidence in 2022 are India, Indonesia, the Philippines, China, Nigeria, Pakistan, Myanmar, Bangladesh, Viet Nam and the Democratic Republic of the Congo.

WHO guidelines *(32)*.[1] The microbiological detection of TB using WHO-recommended tests is critical because it allows people to be correctly diagnosed, is necessary to test for drug resistance and ensures that the most effective treatment regimen (depending on the pattern of drug resistance) can be selected as early as possible.

Of the 6.2 million people diagnosed with pulmonary TB worldwide in 2022, 63% were bacteriologically confirmed (**Fig. 25**). This was the same level as in 2021. There was some variation among the six WHO regions, with the highest percentage achieved in the Region of the Americas (79%) and the lowest in the Eastern Mediterranean Region (56%). There was also considerable variation among countries. In general, levels of confirmation were lowest in low-income countries (median, 71%), and highest in high-income countries (median, 91%) where there is wide access to the most sensitive diagnostic tests.

The use of rapid tests is growing, although it remains far too limited (**Fig. 26**). A WHO-recommended rapid diagnostic test (WRD) was used as the initial test for 47% (3.5 million) of the 7.5 million people newly diagnosed with TB in 2022, up from 38% (2.5/6.4 million) in 2021 and 33% (1.9/5.8 million) in 2020. Coverage will need to more than double to reach the new target set at the 2023 UN high-level meeting on TB, which is 100% by 2027 (**Table 2**).

There was substantial variation in the coverage of rapid testing among regions and countries in 2022 (**Fig. 26**, **Fig. 27**). Among WHO regions, the highest levels of coverage were in the European Region (77%) and the Western Pacific Region (65%) and the lowest was in the South-East Asia Region (39%). At country level, 55 countries achieved levels of at least 80% in 2022, but it was less than 20% in 50 countries. Among the 49 countries in one of the three global lists of high burden countries (for TB, HIV-associated TB and MDR/RR-TB),[2] 31 reported that a WRD had been used as the initial test for more than half of their notified TB cases in 2022, up from 27 in 2021 and 21 in 2020.

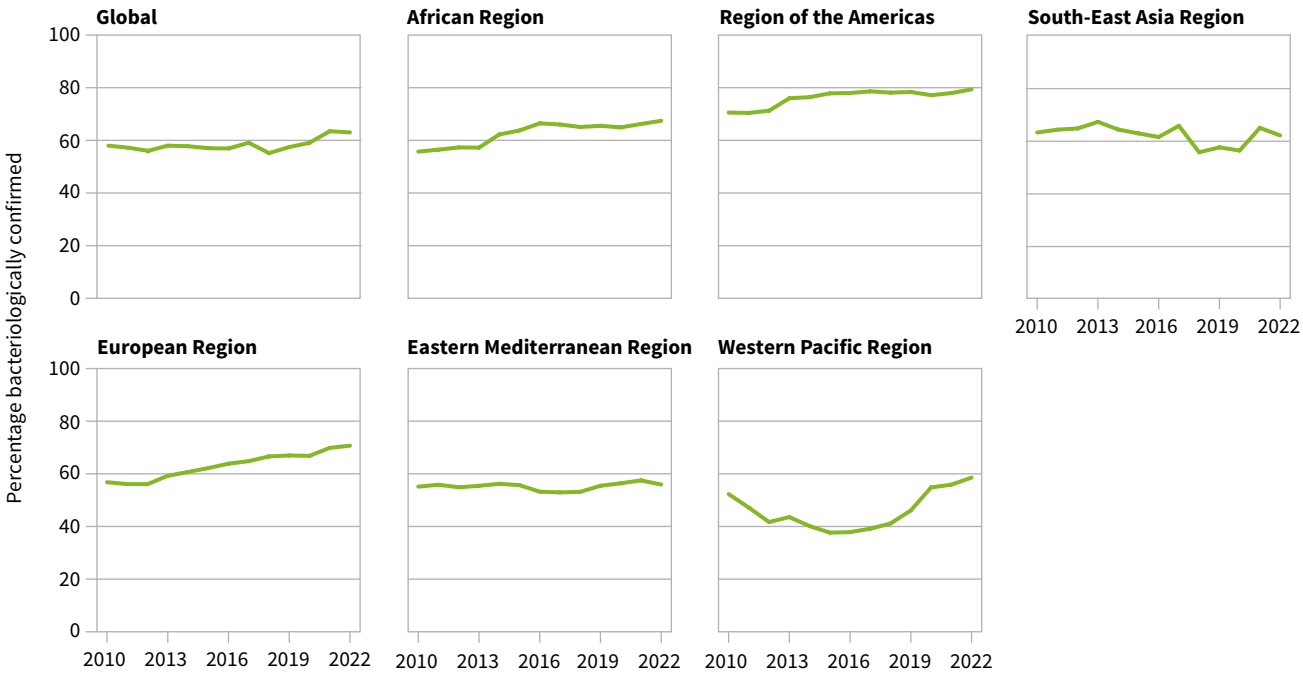
The global coverage of HIV testing among people diagnosed with TB remained high in 2022, at 80% (up from 76% in 2021 and 73% in 2020). At regional level, the highest coverage in 2022 was achieved in the WHO African Region (89%) and the European Region (93%). In

[1] To facilitate implementation of WHO guidelines, WHO also publishes operational handbooks. More recently, WHO has developed online courses that are designed for health care workers and people working with NTPs. To date, these cover TB prevention, diagnostics, treatment, and use of data for decision making. The courses are free of charge and can be accessed via the End TB channel in OpenWHO (openwho.org) and the WHO Academy.

[2] See **Annex 3**.

FIG. 25

Percentage of people newly diagnosed with pulmonary TB who were bacteriologically confirmed, globally and for WHO regions,[a] 2010–2022



[a] Data are for notified cases. The calculation for years prior to 2013 is based on smear results, except for the European Region where data on confirmation by culture were also available for the period 2010–2012.

FIG. 26

Percentage of people newly diagnosed with TB who were initially tested with a WHO-recommended rapid diagnostic test (WRD), globally and for WHO regions, 2015–2022

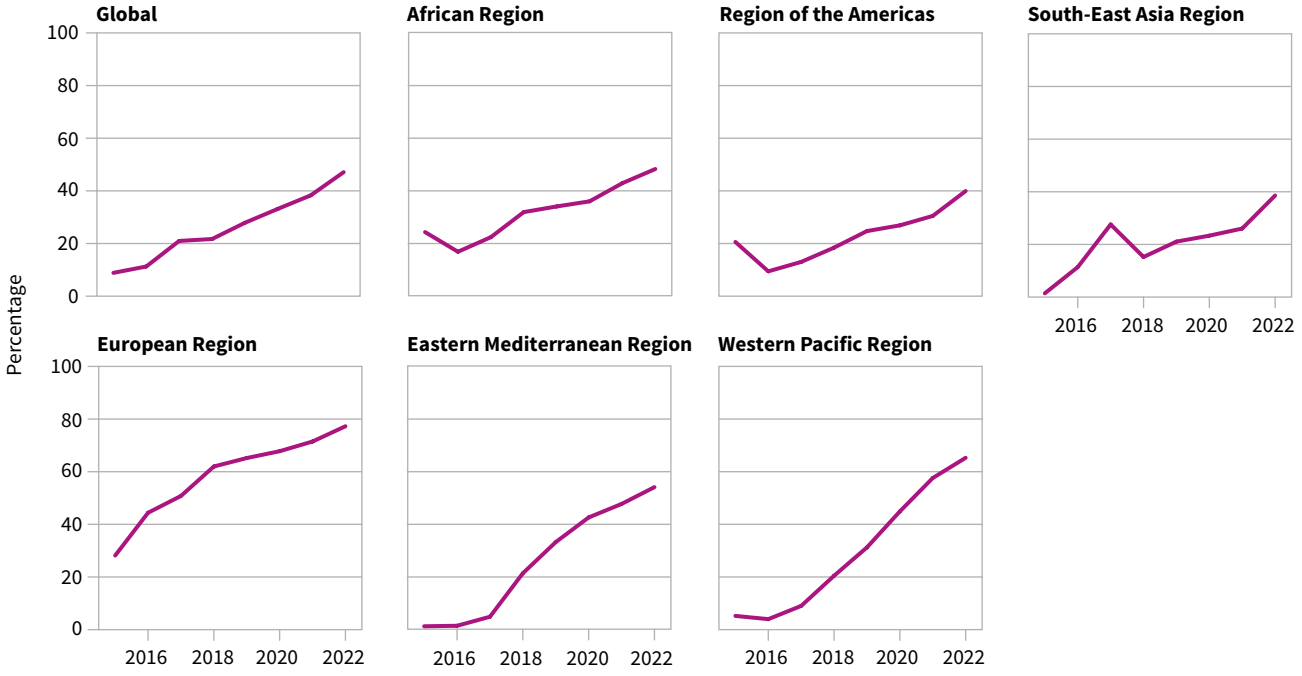
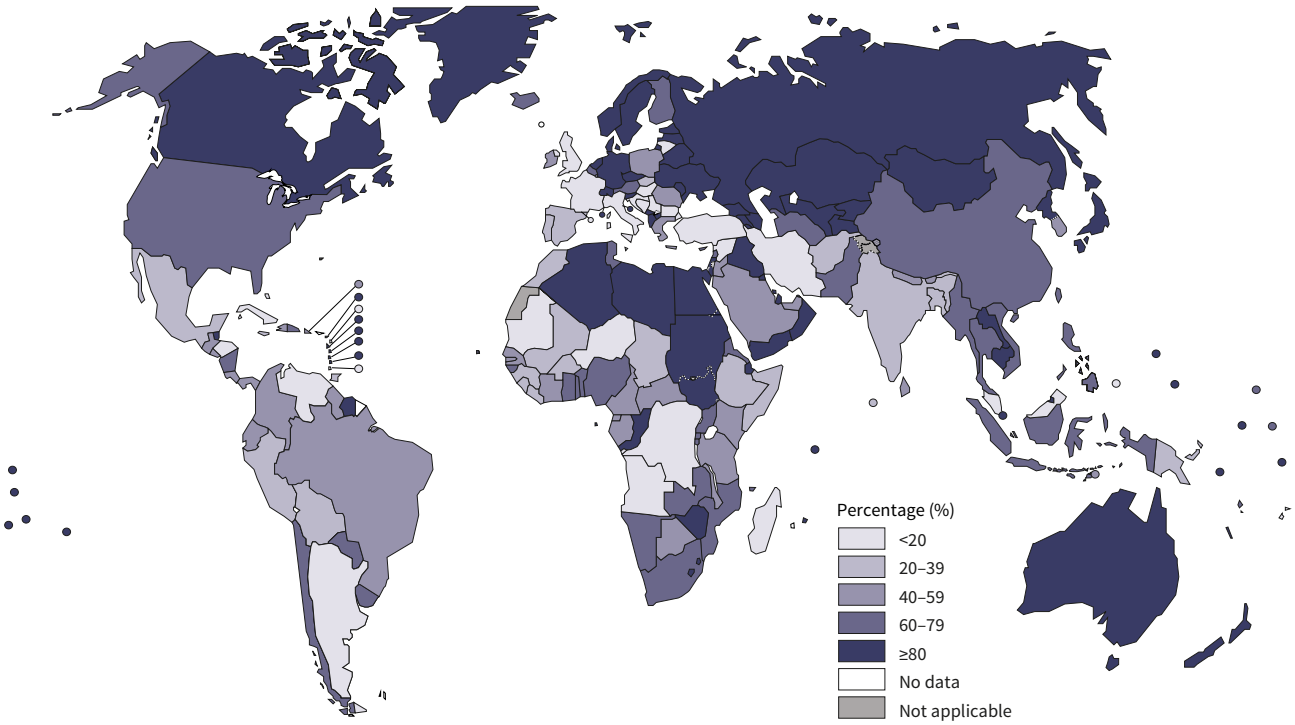


FIG. 27

Percentage of people newly diagnosed with TB who were initially tested with a WHO-recommended rapid diagnostic test (WRD), by country, 2022



97 countries or areas, at least 90% of people diagnosed with TB knew their HIV status; this included 32 of the 47 countries in the African Region, where the burden of HIV-associated TB is highest.

Among people living with HIV who develop TB, both TB treatment and antiretroviral therapy (ART) for HIV are required to prevent unnecessary deaths from TB and HIV. The global coverage of ART for people living with HIV who were newly diagnosed and reported with TB was 85% in 2022, the same as in 2021. However, when compared with the total number of people living with HIV estimated to have developed TB in 2022, coverage was only 54% (up from 46% in 2021). This was far below the overall level of coverage of ART for people living with HIV, which was 76% at the end of 2022 *(33)*. The main reason for the relatively low coverage was the big gap between the estimated number of people living with HIV who developed TB in 2022 (a best estimate of 671 000) and the reported number of people living with HIV who were diagnosed with TB in 2022 (426 958).

A very positive finding from both 2020 and 2021 was that treatment outcomes for people treated for TB were maintained or improved (**Fig. 28**). Among people newly diagnosed with TB and enrolled on first-line treatment,[1] the treatment success rate was 86% for those enrolled in 2020 (the same level as in 2019) and 88% for those enrolled in 2021. This shows that, despite the many disruptions caused by the COVID-19 pandemic, the quality of treatment for those diagnosed with TB was maintained in 2020 and 2021. Treatment success rates remain lower among people living with HIV (79% globally in 2021), although there have been steady improvements over time. The treatment success rate for children (aged 0–14 years) was 91% in 2021, an increase from 88% in both 2020 and 2019. Among 26 high burden countries[2] that reported treatment outcome data disaggregated by sex, the treatment success rate was slightly higher in 2021 among females (90%) than males (88%).

Provision of TB treatment to HIV-negative people is estimated to have averted 38 million deaths between 2010 and 2022; among people living with HIV who were diagnosed with TB, the combination of TB treatment and ART is estimated to have averted 6.4 million deaths between 2010 and 2022 (**Table 4**).

[1] The latest WHO guidelines on treatment for drug-susceptible TB were published in 2022 *(34)*. **Annex 1** provides a summary of recommended treatments.

[2] Since 2021, WHO has requested data on treatment outcomes disaggregated by sex from the 49 countries in one of the three lists of high burden countries (**Annex 3**). The countries from which such data are requested may be expanded in future (for example, to include all countries with case-based digital surveillance systems for TB).

TABLE 4

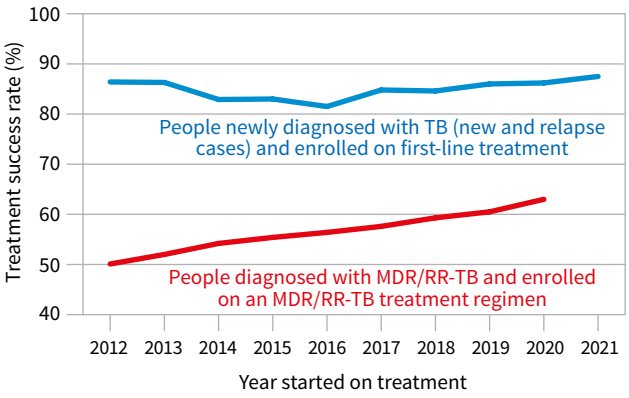
Cumulative number of deaths averted by a) TB treatment as well as b) antiretroviral treatment for people diagnosed with TB who were also living with HIV, 2010–2022 (in millions), globally and by WHO region

WHO REGION	PEOPLE WITHOUT HIV		PEOPLE WITH HIV[a]		TOTAL	
	BEST ESTIMATE	UNCERTAINTY INTERVAL	BEST ESTIMATE	UNCERTAINTY INTERVAL	BEST ESTIMATE	UNCERTAINTY INTERVAL
African Region	5.2	4.3–6.2	4.8	4.1–5.5	10	8.9–11
Region of the Americas	1.2	1.0–1.3	0.23	0.21–0.24	1.4	1.3–1.5
South-East Asia Region	18	15–21	0.85	0.53–1.2	19	16–22
European Region	1.1	0.95–1.2	0.21	0.18–0.25	1.3	1.2–1.4
Eastern Mediterranean Region	3.4	2.9–3.9	0.062	0.047–0.078	3.5	3.0–4.0
Western Pacific Region	9.0	8.0–10	0.32	0.26–0.37	9.3	8.3–10
Global	**38**	**33–43**	**6.4**	**5.5–7.3**	**44**	**39–49**

[a] Deaths from TB among people with HIV are officially classified as deaths caused by HIV/AIDS (with TB as a contributory cause). This is the reason why the estimates make a clear distinction between people with and without HIV.

FIG. 28

Global success rates for people treated for TB, 2012–2021[a]



[a] 2012 is the first year for which WHO collected data about treatment outcomes for MDR/RR-TB.

Drug-resistant TB: diagnosis and treatment

Slow recovery, targets not achieved

WHO uses five categories to classify cases of drug-resistant TB: isoniazid-resistant TB; RR-TB and MDR-TB (defined above); extensively drug-resistant TB (XDR-TB); and pre-XDR-TB. Pre-XDR-TB is TB that is resistant to rifampicin and any fluoroquinolone (a class of second-line anti-TB drug). XDR-TB is TB that is resistant to rifampicin, plus any fluoroquinolone, plus at least one of either bedaquiline or linezolid.

Detection of drug resistance requires bacteriological confirmation of TB and testing for drug resistance using rapid molecular diagnostic tests, culture methods or sequencing technologies.

Since 2018, WHO has recommended all-oral regimens for the treatment of MDR/RR-TB, marking a major advance compared with previous regimens that included injectable agents *(35)*. The latest guidelines for treatment of DR-TB, updated in 2022, include three major categories of regimen *(36)*. The first is a short 6-month all-oral regimen for people with MDR/RR-TB (which may be extended by 3 months if necessary) consisting of bedaquiline, pretomanid, linezolid and moxifloxacin, referred to as BPaLM; for people with pre-XDR-TB, the regimen can be used without moxifloxacin and is referred to as BPaL.[1] The second category is all-oral short regimens of 9 months for people with MDR/RR-TB (which may be extended by 2 months if necessary). The third category is longer regimens of 18–20 months that may include an injectable drug (amikacin). The short 6-month regimen is prioritized for use and is recommended for people aged 14 years and older who have MDR/RR-TB or pre-XDR-TB.

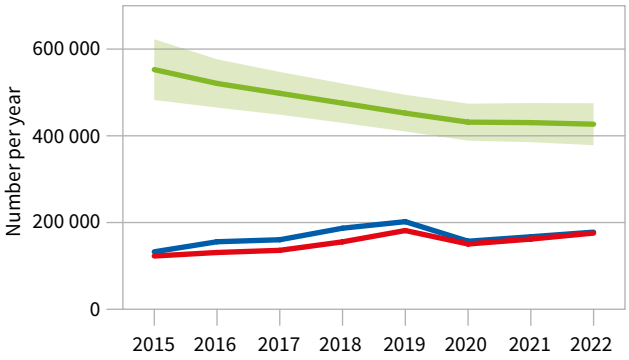
Globally in 2022, 73% of people (2.9/4.0 million) diagnosed with bacteriologically confirmed pulmonary TB were tested for rifampicin resistance, up from 69% (2.4/3.5 million) in 2021 and above the pre-pandemic level of 62% (2.2/3.6 million) in 2019. Among those tested, 149 511 people with MDR/RR-TB and 27 075 people with pre-XDR-TB or XDR-TB were detected, giving a combined total of 176 586 (4.4% of those tested). Despite increased testing coverage and an increase in the absolute number of people tested, the number of people detected with MDR/RR-TB was lower in 2022 than in 2019 (when the total was 202 009, 5.6% of those tested). This is consistent with the estimated decline in the proportion of people with TB who have MDR/RR-TB (**Fig. 16**).

Worldwide, 175 650 people with MDR/RR-TB were enrolled on treatment in 2022, up 8.5% from 161 843 in 2021 and up 17% from 150 510 in 2020 but still below the pre-pandemic level of 181 533 in 2019 (**Fig. 29**, **Fig. 30**).

[1] The BPaLM/BPaL regimen is one of the featured topics of this report.

FIG. 29

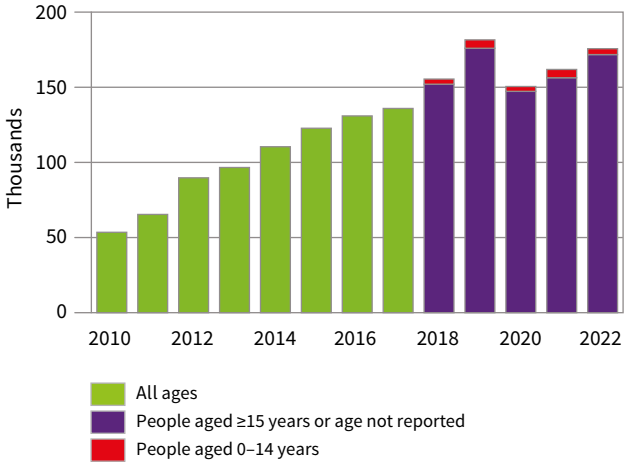
Global number of people diagnosed with MDR/RR-TB (blue) and number enrolled on an MDR-TB treatment regimen (red), compared with estimates of the global number of incident cases of MDR/RR-TB (95% uncertainty interval shown in green), 2015–2022[a]



[a] The time period corresponds to the period for which estimates of the incidence of MDR/RR-TB are available.

FIG. 30

The global number of people reported to have been enrolled on treatment for MDR/RR-TB, 2010–2022[a]



[a] Global data disaggregated by age are not available for the years before 2018.

This level of enrolment is equivalent to about 43% of the estimated number of people who develop MDR/RR-TB each year (**Fig. 15**, **Fig. 29**).

The global targets set at the UN high-level meeting in 2018 for the number of people to be treated for drug-resistant TB were not reached (**Fig. 23**). The cumulative number of people with MDR/RR-TB who were reported as being enrolled on treatment from 2018 to 2022 was 825 000, only 55% of the 5-year target (2018–2022) of 1.5 million. For children specifically, the cumulative number was 21 600, only 19% of the 5-year target of 115 000.

Ten countries account for about 70% of the global gap between the estimated global number of people who develop MDR/RR-TB each year (incident cases of MDR/RR-TB) and the global number of people enrolled on treatment in 2022: China, the Democratic People's Republic of Korea, India, Indonesia, Myanmar, Nigeria, Pakistan, the Philippines, Ukraine and Viet Nam. To make substantial progress in closing this gap, improvements in the coverage of testing for drug resistance and access to treatment are needed in these countries.

There have been steady improvements in the treatment success rate for people diagnosed with MDR/RR-TB (**Fig. 28**). Globally in 2020 (the latest patient cohort for which data are available), the treatment success rate was 63%, up from 60% in 2019 and much better than the level of 50% in 2012.[1] Among WHO regions, the treatment success rate in 2020 ranged from 55% in the European Region to 73% in the Eastern Mediterranean Region.

By the end of 2022, 40 countries had started to use the new 6-month BPaLM/BPaL regimen to treat people with MDR/RR-TB or pre-XDR-TB. A total of 92 countries were using the shorter 9-month oral regimens for the treatment of MDR/RR-TB, almost the same as in 2021[2] and up from 65 in 2020.

TB prevention

Global recovery, but most targets missed

The main health care intervention available to reduce the risk of TB infection progressing to active TB disease is TB preventive treatment. Other preventive interventions are TB infection prevention and control, and vaccination of children with the bacille Calmette-Guérin (BCG) vaccine, which can confer protection, especially from severe forms of TB in children.

WHO recommends TB preventive treatment for people living with HIV, household contacts of people diagnosed with bacteriologically confirmed pulmonary TB and clinical risk groups (e.g. those receiving dialysis) *(37)*.[3] Options include: a weekly dose of isoniazid and rifapentine for 3 months; a daily dose of isoniazid and rifampicin for 3 months; a daily dose of isoniazid and rifapentine for 1 month; a daily dose of rifampicin for 4 months; and a daily dose of isoniazid for 6 months or longer.

The global number of people provided with TB preventive treatment in 2022 was 3.8 million, up from 2.9 million in both 2020 and 2021 and above the pre-COVID

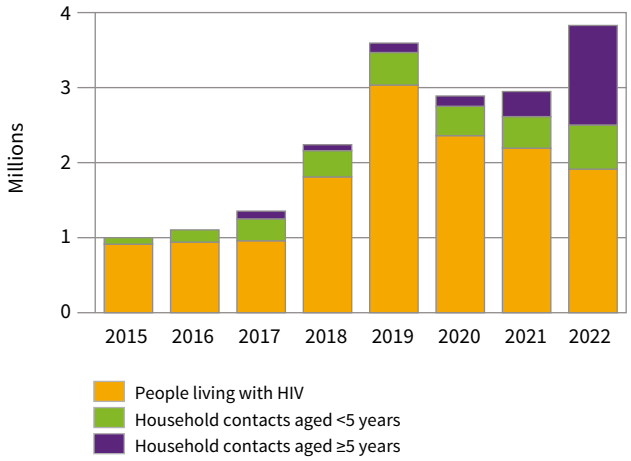
[1] 2012 is the first year for which WHO collected data on outcomes for people enrolled on treatment for MDR/RR-TB.

[2] The total was 93 in 2021.

[3] Addressing broader determinants that influence TB epidemics can also help to prevent TB infection and disease. These are discussed below.

FIG. 31

The global number of people provided with TB preventive treatment, 2015–2022



level of 3.6 million in 2019 (**Fig. 31**). There was a particularly noticeable increase in the number of household contacts enrolled on TB preventive treatment: from 0.76 million in 2021 to 1.9 million in 2022. In contrast, the number of people living with HIV who were enrolled on TB preventive treatment fell slightly, from 2.2 million in 2021 to 1.9 million in 2022.

Despite progress to beyond pre-pandemic levels in 2022, the global target set at the UN high-level meeting in 2018 was missed by a considerable margin (**Fig. 32**). A cumulative total of 15.5 million people were provided with TB preventive treatment in the 5-year period 2018–2022, equivalent to 52% of the target of 30 million.

More positively, the subtarget for people living with HIV was far surpassed; the total of 11.3 million was almost double the target of 6 million.

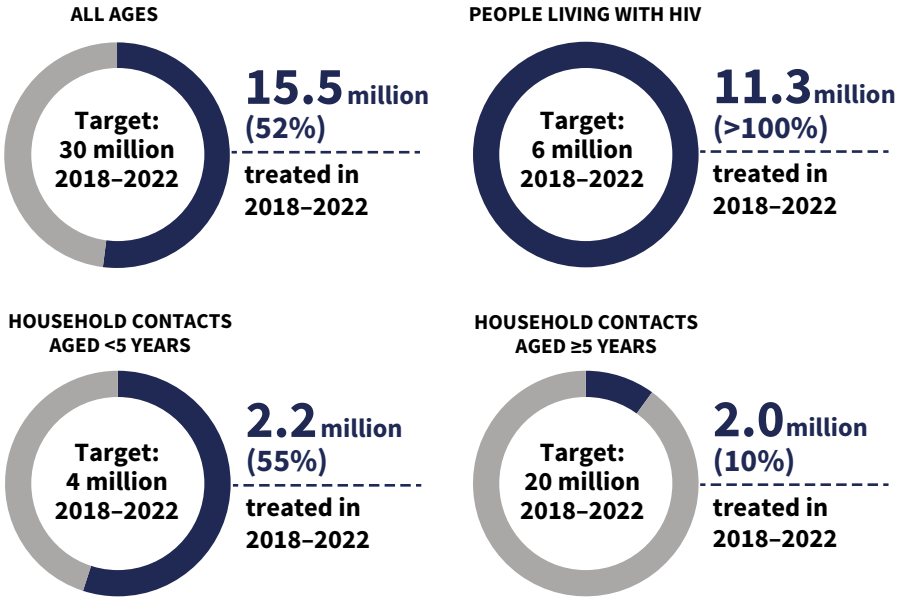
The cumulative total for household contacts was 4.2 million, equivalent to 17% of the 5-year target of 24 million for the period 2018–2022; this number included 2.2 million children aged under 5 years (55% of the 5-year subtarget of 4 million) and 2.0 million people in older age groups (10% of the 5-year subtarget of 20 million) (**Fig. 32**).

In 83 countries that reported outcomes, the median completion rate for household contacts who started treatment in 2021 was 89%, up from 86% in both 2019 and 2020. For people living with HIV, the median completion rate in 31 countries that reported data was 81%, compared with 87% in 20 countries that reported data for 2020.

Substantial intensification and expansion of efforts and investment are needed to improve the provision of TB preventive treatment. This includes providing more

FIG. 32

The global numbers of people provided with TB preventive treatment between 2018 and 2022, compared with targets set at the 2018 UN high-level meeting on TB



TB screening at household level, improving the follow-up to TB screening at household level and among people living with HIV, and increasing access to shorter (1–3 months) rifamycin-based regimens. Treatment using these shorter regimens is expanding: in 2022, 0.60 million people were reported to have been treated in 74 countries, a three-fold increase from 0.19 million people in 52 countries in 2021.

The ratio of the TB notification rate among health care workers to the TB notification rate in the general adult population reflects the effectiveness of TB infection control in health facilities; the ratio should be about 1. However, in 2022 it was greater than 1 in 14 countries that reported five or more TB cases among health care workers (unchanged from 2021).

Following concerning declines in the global coverage of BCG vaccination during the COVID-19 pandemic, from 89% in 2019 to 84% in 2021, there was a recovery to 87% in 2022 *(38)*.

Funding for essential TB services

Funding down since 2019, far below target

Progress in reducing the burden of TB disease requires adequate funding for TB diagnostic, treatment and prevention services, sustained over many years. However, funding in LMICs – which account for 99% of the reported number of people newly diagnosed with TB each year – falls far short of what is needed and remains below pre-pandemic levels.

In 2022, the funding available for TB diagnostic, treatment and prevention services in LMICs was US$ 5.8 billion (in constant 2022 US$).[1] This level of funding was similar to that of 2020 and 2021 but down more than 10% from US$ 6.5 billion in 2019 (**Fig. 33**).[2,3] The total of US$ 5.8 billion was only 44% of the global target of US$ 13 billion annually by 2022 (**Table 1**) and only 38% of the US$ 15.0 billion that was estimated to be required in 2022 in the Stop TB Partnership's *Global Plan to End TB, 2018–2022 (39)*. It is far below the new targets of US$ 22 billion by 2027 and US$ 35 billion by 2030 set at the second UN high-level meeting on TB in September 2023 (**Table 2**); both targets were informed by the *Global Plan to End TB, 2023–2030 (40)*.

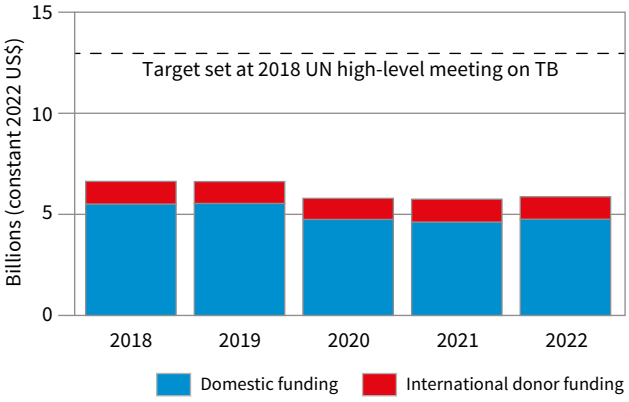
[1] All amounts quoted in this subsection are in constant 2022 US$. Numbers should not be directly compared with those in previous reports, given adjustments to the whole time series that are made for each new report, to account for inflation.

[2] These amounts include funding reported to WHO by NTPs and estimates (produced by the WHO Global Tuberculosis Programme) of the resources used to provide inpatient and outpatient care to the reported number of people newly diagnosed with TB (**Fig. 1**).

[3] The data sources, boundaries, accounting rules, and estimation methods used in this report differ from those of the System of Health Accounts 2011 (SHA2011). The data on available funding for TB are not comparable with the disease expenditure data, including for TB, that are reported in WHO's Global Health Expenditure Database.

FIG. 33

Funding available for TB prevention, diagnostic and treatment services in 134 low- and middle-income countries compared with the global target set at the 2018 UN high-level meeting on TB of at least US$ 13 billion per year,[a,b,c,d] 2018–2022



[a] Sources: data reported by NTPs and estimates produced by the WHO Global Tuberculosis Programme.

[b] The data sources, boundaries, accounting rules, and estimation methods used in this report are different from those of the system of Health Accounts 2011 (SHA2011). The TB funding data reported here are thus not comparable with the disease expenditure data, including for TB, that are reported in WHO's Global Health Expenditure Database.

[c] The 134 countries accounted for 99% of the world's officially reported TB cases in 2022.

[d] Values for 2018–2021 are higher than those shown in the Global Tuberculosis Report 2022, since they have been inflated (for comparability with data for 2022) to constant US$ values for 2022.

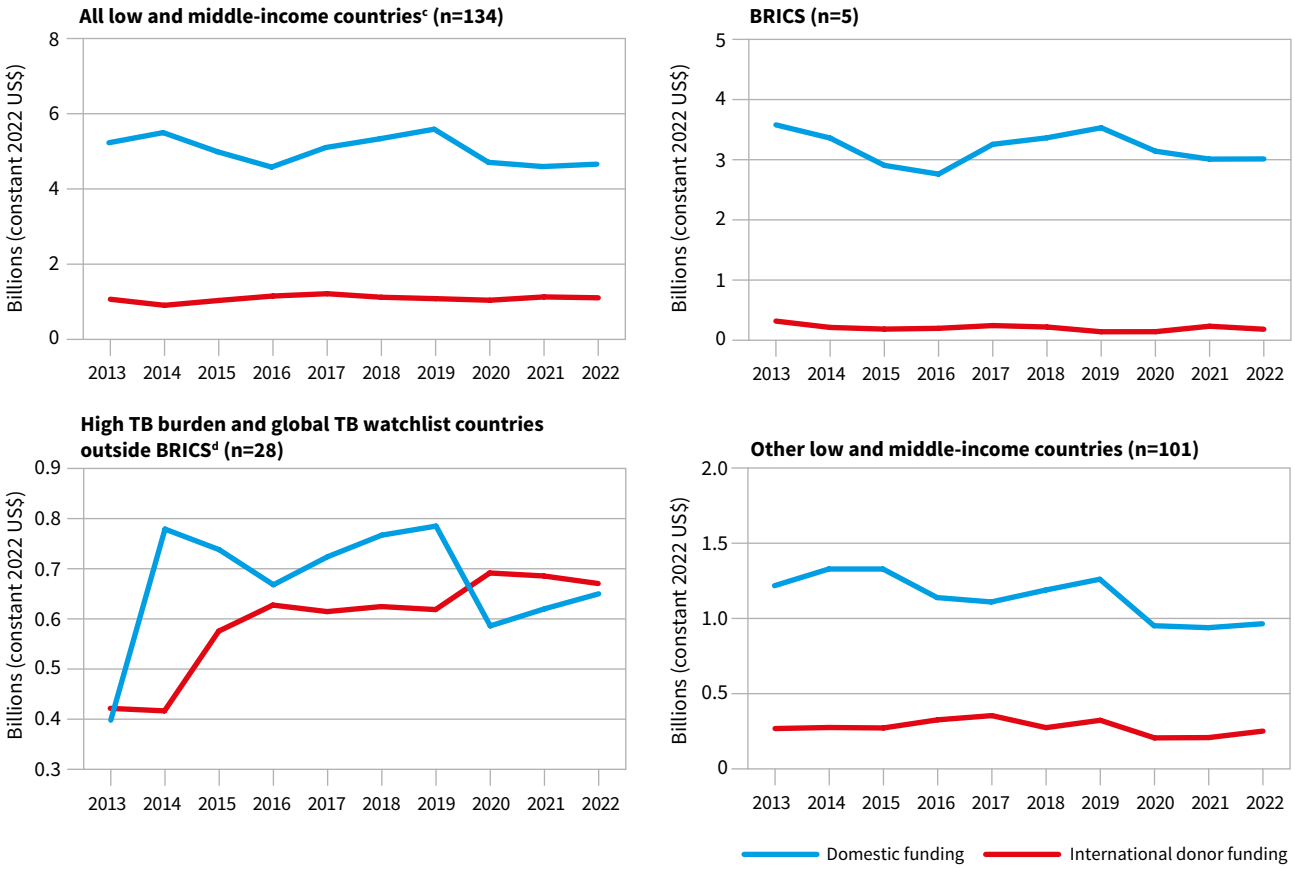
Of the total available funding of US$ 5.8 billion in 2022, US$ 3.5 billion was for diagnosis and treatment of drug-susceptible TB and US$ 2.1 billion was for treatment and management of drug-resistant TB.[4,5] Both these amounts are less than half of the requirements for 2022 that were estimated in the Global Plan *(39)*. The remaining amount included spending on TB preventive treatment (covering drugs only) and interventions specifically related to HIV-associated TB.

[4] The category of drug-susceptible TB includes funding reported by NTPs for the following items: laboratory equipment and supplies; anti-TB drugs; programme management (including staff and activities); operational research and surveys; patient support; and miscellaneous items. It also includes WHO estimates of funding for inpatient and outpatient care for people treated for drug-susceptible TB, which are based on WHO estimates of the unit costs of bed-days and visits combined with the average number of outpatient visits and bed-days per TB patient as reported by NTPs. The category of drug-resistant TB includes anti-TB drugs required for treatment of MDR/RR-TB (including pre-XDR-TB and XDR-TB), any programme management (staff and activity) costs specifically required for the provision of care to people with drug-resistant TB, and WHO estimates of funding for inpatient and outpatient care. Further details are provided in Section 4 of the report webpages.

[5] The categories for which funding is reported to WHO do not allow for funding for the diagnosis of drug-resistant TB specifically to be distinguished. In data analysis, the category of laboratory supplies and equipment is allocated to drug-susceptible TB. Rapid tests recommended by WHO can detect TB and RR-TB simultaneously.

FIG. 34

Funding available for TB prevention, diagnostic and treatment services in 134 low- and middle-income countries and 3 other country groups,[a,b] 2013–2022



BRICS: Brazil, Russian Federation, India, China, South Africa.

[a] Sources: data reported by NTPs and estimates produced by the WHO Global Tuberculosis Programme.

[b] The data sources, boundaries, accounting rules, and estimation methods used in this report are different from those of the System of Health Accounts 2011 (SHA2011). The TB funding data reported here are thus not comparable with the disease expenditure data, including for TB, that are reported in WHO's Global Health Expenditure Database.

[c] The 134 countries accounted for 99% of the world's officially reported TB cases in 2022.

[d] The two global TB watchlist countries included are Cambodia and Zimbabwe.

As in previous years, most of the funding available in LMICs in 2022 (US$ 4.7 billion out of a total of US$ 5.8 billion; i.e. 80%) was from domestic sources (**Fig. 33**). Between 2019 and 2022, there was a decline of US$ 0.8 billion in funding from domestic sources and a slight increase (of US$ 0.1 billion) in funding from international donors.

The aggregate figure for the share of funding provided from domestic sources in LMICs continues to be strongly influenced by Brazil, the Russian Federation, India, China and South Africa (BRICS). Together, these five countries accounted for US$ 3.0 billion (65%) of the total of US$ 4.7 billion that was provided from domestic sources in 2022 (**Fig. 34**). Overall, domestic sources accounted for 94% of the funding for TB diagnostic, treatment and prevention services in BRICS and all of the funding used in Brazil, China and the Russian Federation.

In other LMICs, international donor funding remains crucial (**Fig. 33**). For example, in 2022, it accounted for 52% of the funding available for TB services in the 26 high TB burden and the two global TB watchlist countries (Cambodia and Zimbabwe) outside BRICS, and 61% of the funding available in low-income countries.

The total amount of international donor funding reported to WHO by NTPs in LMICs has been around US$ 1.1 billion per year since 2013 (**Fig. 34**).[1] The main source for many years has been the Global Fund to Fight AIDS, Tuberculosis and Malaria (the Global Fund); its contribution in 2022 was 75%, slightly less than the level of 76% in 2021. The United States government is the largest contributor of funding to the Global Fund

[1] Data on TB expenditures and funding that are reported to WHO by NTPs do not include all the international donor funding that is provided to LMICs (e.g. funding channelled to entities outside the NTP). A comprehensive analysis of international donor funding for TB, based on donor reports to the Organisation for Economic Co-operation and Development (OECD), is one of the "featured topics" on the report webpages.

(about one-third) and is also the largest bilateral donor; overall, it contributes about 50% of international donor funding for TB (for details, see the **featured topic** on international donor funding).

Substantial increases in both domestic and international funding for TB are urgently required.

Variation in the share of funding from domestic sources within a given income group suggests that there is scope to increase domestic funding in some high TB burden and global TB watchlist countries.

Mobilization of increased levels of funding will require the development of strong national strategic plans for TB that are properly costed, to which countries have committed at the 2023 UN high-level meeting on TB (**Table 3**). WHO has recently updated its guidance on national strategic planning *(41)*; the TB module of the Integrated Health Tool for planning and costing (IHT) has also been recently upgraded by WHO and is now available for use by countries.[1]

UHC, TB determinants and multisectoral accountability

Faster progress required, TB target off track

Global TB targets for reductions in TB disease burden can only be achieved if TB diagnostic, treatment and prevention services are provided within the context of progress towards UHC, and if there is multisectoral action to address the broader determinants that influence TB epidemics. For example, the 2025 milestone of the End TB Strategy – a 75% reduction in the number of deaths caused by TB (compared with 2015) – requires that not more than 6.5% of people who develop TB disease die from it;[2] this is only feasible if everyone with TB can promptly access diagnostic and treatment services.

UHC means that everyone can obtain the health services they need without suffering financial hardship *(42)*. Through their adoption of the SDGs, all countries have committed to achieving UHC by 2030: Target 3.8 is "Achieve universal health coverage, including financial risk protection, access to quality essential healthcare services and access to safe, effective, quality and affordable essential medicines and vaccines for all" *(1)*. The two indicators to monitor progress towards this target are a UHC service coverage index (SCI) (Indicator 3.8.1), and the percentage of the population experiencing household expenditures on health care that are "large" in relation to household expenditures or income (Indicator 3.8.2).[3] The SCI can take values from 0 (worst) to 100 (best) and is calculated using 16 tracer indicators, one of which is the coverage of TB treatment. In the monitoring of Indicator 3.8.2 by WHO and the World Bank, direct medical expenditures that account for 10% or more of household expenditure or income are classified as "catastrophic" *(43)*.

The latest published data for the two UHC indicators are for 2021 (SCI) and 2019 (catastrophic out-of-pocket expenditures on health) *(43, 44)*.

Worldwide, the SCI increased from a score of 45 (out of 100) in 2000 to 68 in 2019. Most of this progress occurred between 2000 and 2015 and was primarily due to improvements in service coverage for infectious diseases (with only limited changes for other areas of service provision). At regional level, the SCI increased in all six WHO regions between 2000 and 2019; the biggest gains were in the South-East Asia and Western Pacific regions. There were also increases in all four World Bank income groups. In 2020 and 2021, during the COVID-19 pandemic, progress stalled globally (at a value of 68 in 2021) and in most WHO regions and World Bank income groups. In 2021, the WHO regions with the highest values were the European Region (81) and the Region of the Americas (80); the African Region had the lowest value (44).

Among the 30 high TB burden countries, most made progress in service coverage between 2000 and 2019. The largest gains in absolute terms (+30 index points or more) were in China, India, Myanmar, Thailand and Viet Nam. During the COVID-19 pandemic, progress stalled or reversed in most countries. In 2021, the high TB burden countries with the highest SCI values (around 80) were Brazil, China and Thailand; most other countries had values between about 40 and 60.

In contrast to improvements in the SCI, the global level of financial protection for health expenditures worsened continuously between 2010 and 2019 (estimates for later years are not currently available). Worldwide, the proportion of the general population facing catastrophic expenditure on health (using a threshold of >10% annual household income or expenditure) rose from 11.4% (794 million people) in 2010 to 13.5% (1.04 billion people) in 2019 *(43)*. At regional level, higher proportions in 2019 compared with 2010 were estimated for all WHO regions except the Region of the Americas.

National values for the level of financial protection are available for different years and there is more geographical variability compared with the SCI, including within regions. Of the 30 high TB burden countries, estimates of the percentage of the population facing catastrophic health expenditures are particularly high (≥15% of the population) for Angola, Bangladesh, China, India, Nigeria, Sierra Leone and Uganda.

Values for both indicators in the 30 high TB burden countries show that there is a long way to go before the SDG targets for UHC are achieved in most of these countries (**Fig. 35**). Only Thailand stands out as having a high SCI (82 in 2021) and a low level of catastrophic

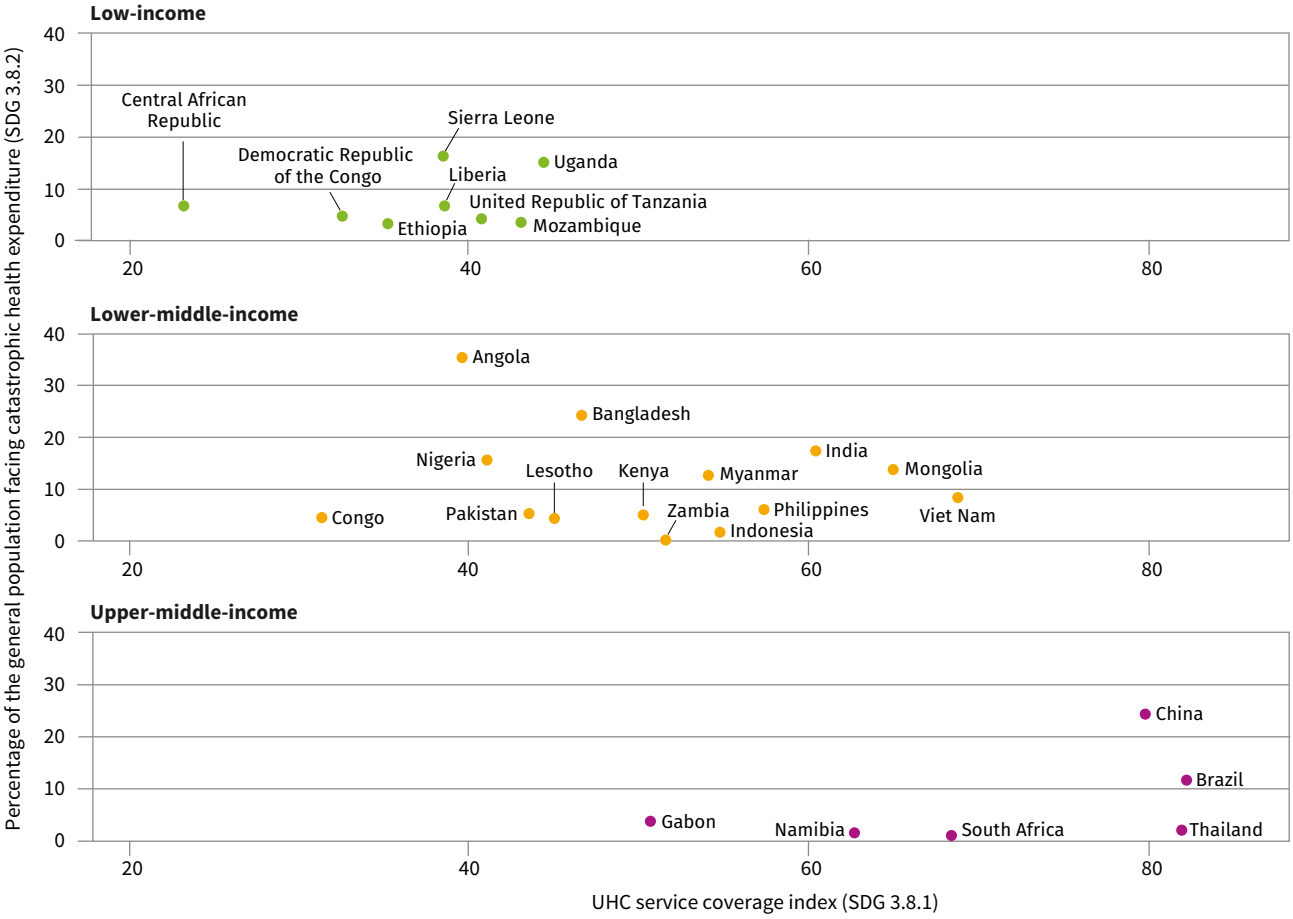
[1] The tool is available at https://tb.integratedhealthtool.org/.

[2] See also **Section 2** of this report. The estimated percentage in 2022 was 12%.

[3] Indicator 3.8.2 is a measure of financial hardship rather than financial barriers to accessing health care. The need for out-of-pocket payments may deter many people from seeking care.

FIG. 35

UHC service coverage index (SDG 3.8.1)[a] and percentage of the general population facing catastrophic health expenditure (SDG 3.8.2),[b] 30 high TB burden countries,[c] stratified by income group[d]



[a] The SCI can take values from 0 (worst) to 100 (best) and is calculated using 16 tracer indicators, one of which is the coverage of TB treatment. Values shown for the SCI are estimates for the latest year for which data for SDG 3.8.2 are available. Values are based on interpolated points between available years over the 2000-2021 period.

[b] Defined as ≥10% of total household consumption or income. The latest available year ranges from 2007 to 2021 for the 30 high TB burden countries.

[c] Data were not available for Democratic People's Republic of Korea and Papua New Guinea.

[d] The classification is for the latest year for which data for SDG 3.8.2 are available.

Source: Global Health Observatory (https://www.who.int/data/gho)

health expenditures (2.0% of households). A Universal Coverage Scheme was established in 2002 to provide an explicit benefit to all citizens of Thailand not already covered by a health insurance scheme in the formal sector, supported by domestic funding and a strong primary health care system *(45)*.

To achieve UHC, substantial increases in investment in health care are critical. From 2000 to 2020, there were striking increases in health expenditure (from all sources) per capita in a small number of high TB burden countries, notably the upper-middle-income countries of Brazil, China, South Africa and Thailand. A steady upward trend was evident in Bangladesh, Cambodia, Ethiopia, India, Indonesia, Lesotho, Mongolia, Mozambique, the Philippines and Viet Nam, and there was a noticeable rise from 2012 to 2017 in Myanmar. Elsewhere, however, levels of spending have been relatively stable, and at generally much lower levels.

Given the importance of UHC to targets for reductions in TB incidence and mortality, the End TB Strategy included a third target: that no TB patients and their households face total costs that are catastrophic *(2, 12)*. The definition of catastrophic used for this TB-specific indicator is total costs (comprising direct medical expenditures, nonmedical expenditures and indirect costs such as income losses) above 20% of annual household income. The key differences between this indicator and the SDG indicator for catastrophic health expenditures (Indicator 3.8.2) are explained in **Box 5**.

Since 2015, a total of 31 countries have completed a national survey of costs faced by TB patients and their households, of which 29 (including 17 of the 30 high TB

Box 5. The difference between "catastrophic total costs" for TB patients and their households, and the SDG indicator of catastrophic expenditures on health care

■ It is important to distinguish between the indicator of "the proportion of the population with large household expenditures on health as a share of total household expenditure or income", which is used within the SDG monitoring framework (SDG Indicator 3.8.2), and the indicator of "the percentage of TB patients and their households facing catastrophic total costs due to TB", which is part of the WHO End TB Strategy.

The SDG indicator is for the *general population*. Household expenditures on health are defined as *direct expenditures* on health by all household members who seek any type of care (preventive, curative, rehabilitative, long-term) for any type of disease, illness or health condition, in any type of setting (outpatient, inpatient, at home). They include both formal and informal expenditures. The indicator attempts to capture the impact of household expenditures on health on household ability to spend on other basic needs. The denominator of the total population includes many people who had no contact with the health system and thus had zero expenditures on health. Although these people did not experience financial hardship because of direct expenditures on health care, they may nonetheless have faced financial barriers to accessing health services that they needed. Hence, the SDG indicator cannot be used as a measure of financial barriers to access to health care.

Due to the nature of the illness, TB patients and their households can face severe direct and indirect financial and economic costs. These pose barriers that can greatly affect their ability to access diagnosis and treatment, and to complete treatment successfully. Costs included in the TB-specific indicator include not only direct medical payments for diagnosis and treatment, but also *direct nonmedical payments* (e.g. for transport and lodging) and *indirect costs* (e.g. lost income). In contrast to SDG Indicator 3.8.2, the TB-specific indicator is restricted to a particular population: *people diagnosed with TB who are users of health services that are part of NTP networks*.

Given these conceptual differences, the percentage of TB patients facing "catastrophic total costs" (defined as direct and indirect costs that account for >20% of their annual household income) is expected to be much higher than the percentage of the general population facing catastrophic expenditures on health care. Hence, the two indicators cannot and should not be compared directly.

burden countries and one of the three global TB watchlist countries)[1] have reported results. The percentage facing catastrophic total costs ranged from 13% (95% confidence interval [CI]: 10–17%) in El Salvador to 92% (95% CI: 86–97%) in Solomon Islands; the pooled average, weighted for each country's number of notified cases, was 49% (95% CI: 37–61%) (**Fig. 36**). Among 25 countries that reported disaggregated data, the percentage facing catastrophic total costs was much higher for people with drug-resistant TB, with a pooled average of 83% (95% CI: 75–90%).

Survey results have been used to inform approaches to health financing, service delivery and social protection that will reduce these costs *(46)*. They have also been used to produce model-based estimates of costs faced by TB patients and their households in other countries *(47)*.

Many new cases of TB are attributable to five risk factors: undernourishment, HIV infection, alcohol use disorders, smoking (especially among men) and diabetes (**Fig. 37**). In the context of the COVID-19 pandemic and its aftermath, as well as war in Ukraine, ongoing conflicts in other parts of the world and global challenges with energy and food security, multisectoral action to address these and other determinants of TB, such as GDP per capita (**Fig. 20**) and poverty, is more important than ever.[2]

The political declaration from the 2023 UN high-level meeting on TB includes commitments to strengthen multisectoral action and accountability (**Table 3**), including through use of the WHO multisectoral accountability framework (MAF-TB) *(48)*. The framework has two major parts: one for the global/regional level; and one for the national level. Each part has four major, inter-related components: commitments; actions; monitoring and reporting; and review. To illustrate how the MAF-TB can be used at national level, WHO has published a checklist that can be used for an initial, baseline assessment, as well as an operational guide and a compendium of country examples *(49–51)*.

Data reported to WHO by NTPs for indicators related to multisectoral accountability show that at country level, there is considerable scope to enhance the engagement of most sectors of government (e.g. agriculture, education, labour, justice, finance and social development) as well the private sector, communities and civil society; and a need for more high-level review of progress, informed by national reports.[3]

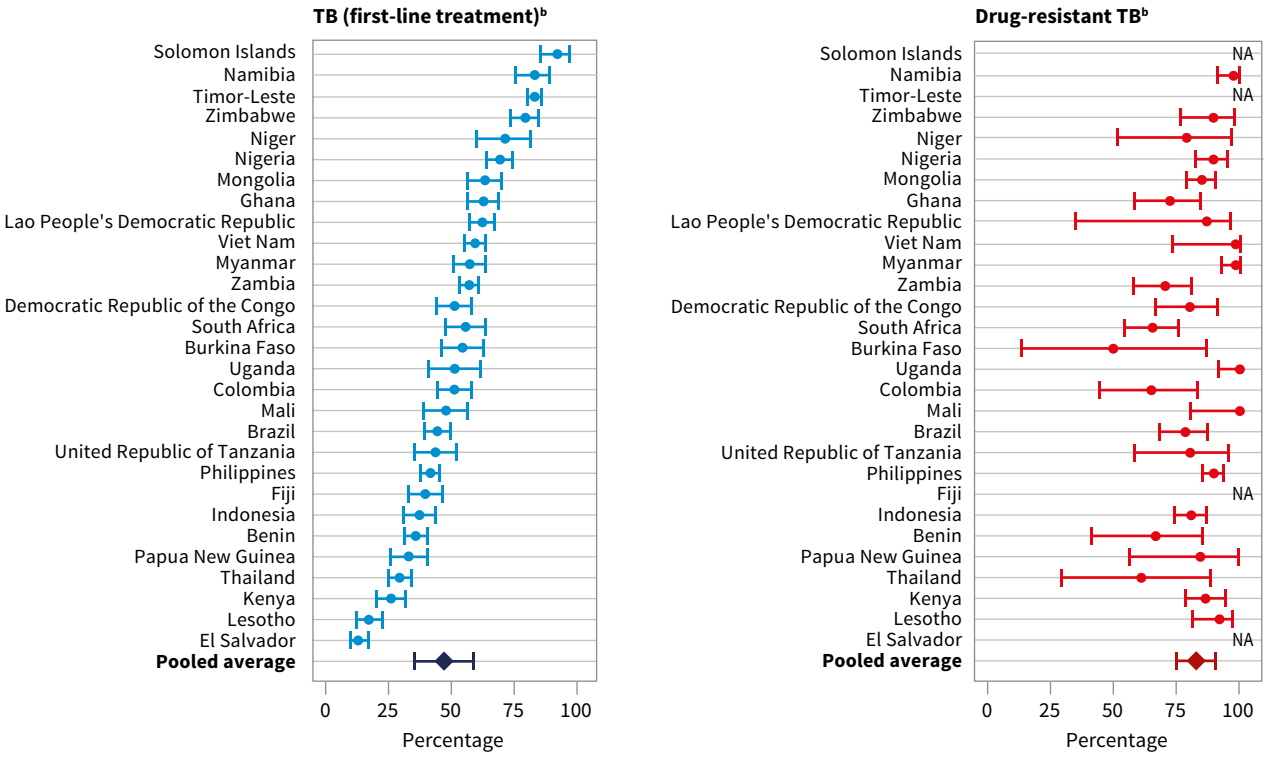
[1] See **Annex 3**.

[2] SDG targets and indicators that are associated with TB incidence are described in **Annex 6**.

[3] For further information, see the "featured topics" component of this report.

FIG. 36

Estimates of the percentage of TB patients and their households facing catastrophic total costs,[a] national surveys completed 2015–2022



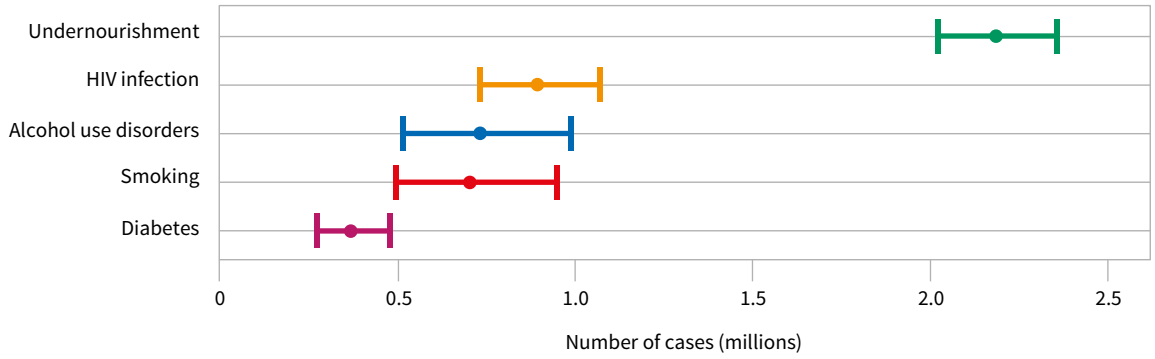
NA – not available.

[a] Defined as direct medical expenditures, direct nonmedical expenditures and indirect costs (e.g. income losses) that sum to >20% of annual household expenditure or income. This indicator is not the same as the SDG indicator for catastrophic health expenditures; see **Box 5** for further explanation.

[b] Disaggregated estimates for TB (first-line treatment) and drug-resistant TB were available for only 25 countries. The calculation of confidence intervals for Mali and Uganda did not account for sampling design.

FIG. 37

Global estimates of the number of TB cases attributable to selected risk factors,[a] 2022



[a] Sources of data used to produce estimates were: Imtiaz s et al. Eur Resp Jour (2017) (https://pubmed.ncbi.nlm.nih.gov/28705945/); Hayashi S et al. Trop Med Int Health (2018) (https://pubmed.ncbi.nlm.nih.gov/30062731/); Lönnroth K et al. Lancet (2010) (https://pubmed.ncbi.nlm.nih.gov/20488524/); World bank sustainable Development Goals Database (http://datatopics.worldbank.org/sdgs/); WHO Global Health Observatory (https://www.who.int/data/gho); and the WHO Global Tuberculosis Programme.

In line with the global part of the MAF-TB and the requests at the 2023 UN high-level meeting on TB (**Table 3**), WHO will continue to lead the coordination of global monitoring, reporting and review, and provide technical support and guidance to countries and partners. WHO's work will also continue to be informed by the WHO Civil Society Task Force on TB.[1]

TB research and innovation

Slow progress, much more investment needed, new vaccine initiatives hold promise

The End TB Strategy targets set for 2030 and 2035 (**Box 2**) cannot be met without intensified research and innovation. When these targets were first established, it was highlighted that technological breakthroughs would be needed by 2025, so that the annual decline in the global TB incidence rate could be accelerated to an average of 17% per year between 2025 and 2035 *(2, 12)*.

Reductions in TB incidence achieved between 2015 and 2022 fall far short of the 2025 milestone of the strategy (8.7% compared with 50%). This means that an even faster rate of decline will now be required to reach the targets for 2030 and 2035.

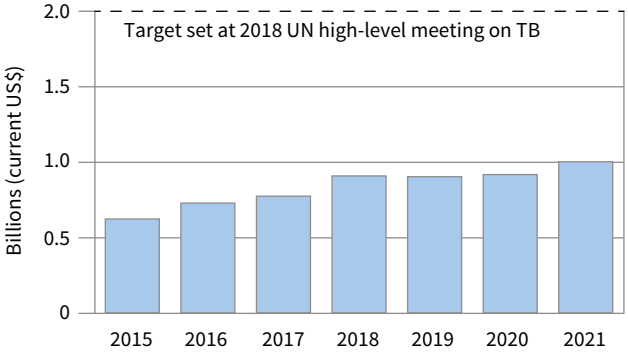
Priorities include a vaccine to reduce the risk of infection, a vaccine or new drug treatment to cut the risk of TB disease in people already infected, rapid diagnostic tests for accurate detection of TB disease at the point of care, and simpler, shorter treatments for TB disease. WHO has developed a global strategy for TB research and innovation, which was adopted by all Member States in 2020 *(52)*. This aims to support accelerated TB research and innovation and improve equitable access to the benefits of research.

There is progress in the development of new TB diagnostics, drugs and vaccines.[2] However, this is constrained by the overall level of investment. Although there have been modest increases in funding in recent years (**Fig. 38**); the most recently published data show a total of US$ 1.0 billion in 2021 *(53)*. This is only half of the global target of US$ 2 billion per year that was set for the period 2018–2022 at the first UN high-level meeting on TB (**Table 1**) and one fifth of the new target of US$ 5 billion per year by 2027 that was set at the second UN high-level meeting in 2023 (**Table 2**).

The diagnostic pipeline has expanded considerably in terms of the number of tests, products or methods in development. These include molecular tests for the detection of TB disease and drug resistance, interferon-gamma release assays (IGRAs) for detection of TB infection, biomarker-based assays for detection of TB infection and disease, computer-aided detection for TB screening using digital chest radiography, and a new class of aerosol-capture technologies for detection of TB disease.

FIG. 38

Funding for TB research, 2015–2021



Source: Treatment action Group, Stop TB partnership. Tuberculosis research funding trends 2005–2021. New York: Treatment Action Group; 2022 (https://www.treatmentactiongroup.org/resources/tbrd-report/tbrd-report-2022)

In 2023, WHO convened a guideline development group that assessed the use of targeted next-generation sequencing for detecting drug-resistant TB directly from sputum specimens, and issued a rapid communication to highlight the key findings *(54)*. This class of tests is a major step towards comprehensive drug susceptibility testing (DST).

In the near future, WHO plans to review evidence on nucleic acid amplification tests to detect TB, including use of alternative sample types and testing for resistance to drugs used to treat drug-susceptible TB, MDR/RR-TB, pre-XDR and XDR-TB. Additional products under consideration for review include point-of-care TB tests, near point-of-care molecular tests, culture-based DST, broth microdilution methods for DST, new IGRAs to test for TB infection and computer-aided detection for digital chest radiography in individuals under 15 years of age (as well as other use cases).

As of August 2023, there were 28 drugs for the treatment of TB disease in Phase I, Phase II or Phase III trials *(55)*. This is an increase from 26 in 2022 and eight in 2015.

The 28 drugs comprise:

- 18 new chemical entities. These are BVL-GSK098, BTZ-043, delpazolid, GSK-286 (GSK 2556286), GSK-3036656, macozinone, OPC-167832, TBAJ-587, TBAJ-876, TBI-223, TBI-166, TBA-7371, telacebec-(Q203), sanfetrinem, SQ109, SPR720 (fobrepodacin), sutezolid, and sudapyridine (WX-081);
- three drugs that have already been approved by WHO for use in treatment. These are bedaquiline, delamanid and pretomanid;

[1] For further information, see https://www.who.int/groups/civil-society-task-force-on-tb.

[2] A high-level summary of the status of the pipelines for new TB diagnostics, drugs and vaccines is provided in this subsection. The report webpages (Section 6) provide more details, including graphics showing the products in each pipeline and links to websites that provide information about the clinical trials that are underway.

- seven repurposed drugs. These are clofazimine, levofloxacin, linezolid, moxifloxacin, rifampicin (high dose), rifapentine and tedizolid.

Various combination regimens with new or repurposed drugs, as well as host-directed therapies, are also in Phase II or Phase III/IV trials or being evaluated as part of operational research projects.

In August 2023, there were at least 29 clinical trials and implementation research studies underway to evaluate drug regimens and models of delivery for TB preventive treatment. Examples include a trial for the prevention of MDR-TB using delamanid, studies to assess how to optimize treatment administration in very young children and people with HIV, and trials of rifamycin monotherapies for durations of 6 or 8 weeks.

In August 2023, there were 16 vaccine candidates in clinical trials (unchanged from 2022): four in Phase I, eight in Phase II and four in Phase III. They included candidates to prevent TB infection and TB disease, and to help improve the outcomes of treatment for TB disease.

Effective vaccines are critical to achieve annual global and national reductions in TB incidence and mortality that are much faster than those achieved historically. Recent high-level actions by WHO to support the development and implementation of new TB vaccines are summarized in **Box 6**.

Box 6. WHO actions to support TB vaccine development and implementation

Recognizing the critical role of TB vaccines in achieving rapid reductions in TB incidence and mortality, WHO has given considerable attention to high-level actions aimed at accelerating vaccine development and use.

In 2022, an investment case that sets out the economic and health impact arguments for TB vaccine development and uptake was developed and published *(56)*. Key findings included the following estimates:

- over 25 years, a vaccine that is 50% effective in preventing disease among adolescents and adults could avert up to 76 million people developing TB disease, 8.5 million deaths from TB, 42 million courses of antibiotic treatment and US$ 41.5 billion in costs faced by TB-affected households;
- over 25 years, a vaccine that is 75% effective could avert up to 110 million new TB cases and 12.3 million deaths;
- for every US$ 1 invested, a vaccine with 50% efficacy could generate an economic return of US$ 7 in terms of averted health costs and increased productivity.

In January 2023, WHO convened a high-level event during the World Economic Forum, to highlight the role of new TB vaccines in the fight against TB *(57)*. The importance of strategic partnerships and investments to boost the development, testing and manufacturing of safe and effective TB vaccines and equitable access to their use once available was highlighted, drawing on lessons learned during the COVID-19 pandemic. At the meeting, the WHO Director-General announced plans to establish an "accelerator council" on new TB vaccines *(58)*.

In March 2023, the WHO Director-General launched a new 5-year (2023–2027) flagship initiative to accelerate progress towards ending TB *(59)*. This included a call for the licensing of at least one new vaccine by 2027.

In September 2023, in association with the second UN high-level meeting on TB, the WHO Director-General launched the "TB vaccine accelerator council" *(60, 61)*. The council aims to boost the TB vaccine pipeline and facilitate the licensing and use of safe TB vaccines that will have a substantial impact on the TB epidemic, by catalysing high-level alignment among national governments, funding agencies, global agencies and communities on both the important challenges in TB vaccine development and the actions required to address them.

4. Conclusions

In 2014 and 2015, all WHO and UN Member States committed to ending the global TB epidemic, through their adoption of the WHO End TB Strategy and UN SDGs. The 2030 targets of the End TB Strategy are a 90% reduction in the number of deaths caused by TB and an 80% reduction in the TB incidence rate, compared with levels in 2015; the 2025 milestones are reductions of 50% and 75%, respectively.

These commitments have been reaffirmed at two UN high-level meetings on TB, in 2018 and most recently September 2023, and reinforced with additional targets related to funding, the provision of treatment to people with TB disease or TB infection, and the availability of new TB vaccines.

Progress in reducing the burden of TB disease was made up to 2019, but the COVID-19 pandemic was a major setback that reversed previous gains. The number of people accessing TB care fell substantially in 2020 and recovered only partially in 2021, resulting in increases in both the number of people dying from TB and the number of people falling ill with the disease, for the first time in many years.

In 2022, there was an encouraging recovery in the number of people being diagnosed with TB and treated, which has started to reverse or mitigate the damaging impact of the pandemic. However, the world as a whole and most regions and countries are far from reaching End TB Strategy milestones and targets. Despite being preventable and usually curable, TB remained the world's second leading cause of death from a single infectious agent in 2022, after COVID-19, and caused almost twice as many deaths as HIV/AIDS.

Ending the global TB epidemic requires that the new and reaffirmed commitments made at the second UN high-level meeting on TB in September 2023 are urgently translated into action.

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ANNEX 1

Basic facts about TB

Tuberculosis (TB) is an old disease. Studies of human skeletons show that it has affected humans for thousands of years *(1)*. Its cause remained unknown until 24 March 1882, when Dr Robert Koch announced his discovery of the bacillus responsible, subsequently named *Mycobacterium tuberculosis (2)*. The disease is spread when people who are sick with TB expel bacteria into the air (e.g. by coughing). TB typically affects the lungs (pulmonary TB) but can also affect other sites (extrapulmonary TB). Most people who develop the disease (about 90%) are adults and there are more cases among men than women.

Diagnostic tests for TB disease have improved substantially in recent years. There are now several rapid molecular tests recommended by WHO as the initial diagnostic test for TB, some of which can detect drug resistance simultaneously *(3)*. These tests can be used at the lower levels of the health system. A point-of-care lateral-flow test performed on urine is also recommended by WHO; its main use is to assist with diagnosis of TB in people with advanced HIV disease, in combination with rapid molecular tests. There are additional rapid molecular tests specifically for the detection of resistance to a variety of first- and second-line anti-TB drugs, while sequencing technologies can be used to provide a comprehensive individual profile of drug resistance. The older method of sputum smear microscopy (developed >100 years ago) is still widely used for TB diagnosis in low and middle-income countries but is increasingly being replaced with rapid tests.

Culture testing remains the reference standard for TB diagnosis. In addition, culture is required for the detection of resistance to newer anti-TB drugs and may also be used as a confirmatory test in settings and situations in which people have a low pre-test probability of having TB disease. Following diagnosis, culture or smear (as opposed to rapid molecular tests) are necessary to monitor an individual's response to treatment.

Without treatment, the death rate from TB is high. Studies of the natural history of TB disease in the absence of treatment with anti-TB drugs (conducted before drug treatments became available) found that about 70% of individuals with sputum smear-positive pulmonary TB died within 10 years of being diagnosed, as did about 20% of people with culture-positive (but smear-negative) pulmonary TB *(4)*.

Effective drug treatments were first developed in the 1940s. The latest WHO guidelines *(5)* include a strong recommendation for a 6-month regimen of isoniazid (H), rifampicin (R), ethambutol (E) and pyrazinamide (Z) for people with drug-susceptible TB (both pulmonary and extrapulmonary): all four drugs for the first two months, followed by H and R for the remaining 4 months. They also include newer recommendations that people aged 12 years and older with drug-susceptible pulmonary TB may be treated with a 4-month regimen of rifapentine (P), H, Z and moxifloxacin (M), and that children and adolescents between 3 months and 16 years of age with non-severe TB (and without suspicion or evidence of resistance to R and H) may be treated with a 4-month regimen (2 months of H, R, Z and sometimes also E, followed by 2 months of H and R). Treatment success rates of at least 85% for people enrolled on the 6-month regimen are regularly reported to WHO by its 194 Member States.

Treatment for people diagnosed with R-resistant TB (RR-TB) and multidrug-resistant TB (MDR-TB, defined as resistance to H and R) requires other regimens. The latest WHO guidelines *(6)* prioritize a new 6-month regimen consisting of bedaquiline (B), pretomanid (Pa), linezolid (L) and moxifloxacin (M), referred to as BPaLM; for people who have pre-extensively drug-resistant TB (pre-XDR-TB, defined as TB that is resistant to R and any fluoroquinolone), the regimen can be used without moxifloxacin (BPaL). Based on currently available safety data, this regimen is recommended only for people aged 14 years and above. For people not eligible for the 6-month regimen, other 9-month or longer regimens can be used *(6)*. Nationally, treatment success rates for RR-TB reported to date have typically been in the range of 50–75%; the global average has been improving in recent years, reaching 63% in the most recent patient cohort for which data are available. This may further improve with expanded use of BPaLM, for which clinical trial data showed a treatment success rate of 89% *(7)*. Treatment for XDR-TB (resistance to R, any fluoroquinolone and at least one of bedaquiline or linezolid) remains much more difficult and treatment success rates are typically low.

A global modelling study published in 2016 estimated that about a quarter of the world's population had been infected with *M. tuberculosis (8)*. Recent analyses and commentary suggest that the number of those currently infected is lower, given that some people will clear

the infection *(9, 10)*. An older modelling study published in 2000 estimated that about 5–10% of people infected with TB will go on to develop TB disease at some point during their lifetime *(11)*. The probability of developing TB disease is much higher among people living with HIV, and among people affected by risk factors such as undernutrition, diabetes, smoking and alcohol consumption.

Preventive treatment is available for people with TB infection. Recommended options include: a weekly dose of H and P for 3 months (3HP), a daily dose of H and R for 3 months (3HR), a daily dose of H and P for 1 month (1HP), a daily dose of R for 4 months (4R), and a daily dose of H for 6 months (6H) or longer *(12)*.

The only licensed vaccine for prevention of TB disease is the bacille Calmette-Guérin (BCG) vaccine. The BCG vaccine was developed almost 100 years ago, prevents severe forms of TB in children and is widely used. There is currently no licenced vaccine that is effective in preventing TB disease in adults, either before or after exposure to TB infection; however, results from a Phase II trial of the M72/AS01E candidate are promising *(13)*.

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ANNEX 2

Data sources and access

A2.1 Database contents

The *Global tuberculosis report 2023* is based on data requested annually from 215 countries and areas, including all 194 World Health Organization Member States. Data are stored in the global TB database which is managed by the TB Monitoring, Evaluation and Strategic Information unit of the Global Tuberculosis Programme, at WHO headquarters.

The Global Tuberculosis Programme has implemented annual rounds of data collection since 1995. The main round of data collection for this report took place in April 2023. As in previous years, data were collected on the following: TB case notifications and treatment outcomes, including breakdowns by TB case type, age, sex, HIV status and drug resistance; laboratory diagnostic services; monitoring and evaluation, including surveillance and surveys specifically related to drug-resistant TB; contact screening and TB preventive treatment; digital systems; TB infection control; engagement of all public and private care providers in TB prevention and care; community engagement; specific elements of the WHO multisectoral accountability framework for TB; budgets of national TB programmes (NTPs); use of general health services (hospitalization and outpatient visits) during treatment; and NTP expenditures. A shortened version of the questionnaire was used for high-income countries as defined by the World Bank[1] or low-incidence countries, defined as countries with an incidence rate of <20 cases per 100 000 population or <10 cases in total in 2021.

High TB burden countries and selected other regional priority countries were also asked to continue reporting monthly or quarterly provisional notification data. This process started in 2020 to monitor trends in the context of the COVID-19 pandemic.

Countries and areas reported data via a dedicated website.[2] Countries in the European Union submitted data on notifications and treatment outcomes to the TESSy system managed by the European Centre for Disease Prevention and Control (ECDC). Data from TESSy were uploaded into the WHO global TB database.

Additional data about the provision and completion of TB preventive treatment to people newly or currently enrolled in HIV care, detection of TB among people newly enrolled in HIV care, and provision of antiretroviral therapy for TB patients living with HIV were collected by the Joint United Nations Programme on HIV/AIDS (UNAIDS). These data were jointly validated by WHO and UNAIDS, and then uploaded into the WHO global TB database.

TABLE A2.1

Reporting of data in the 2023 round of global TB data collection

	COUNTRIES AND AREAS		WHO MEMBER STATES	
	NUMBER	NUMBER THAT REPORTED DATA	NUMBER	NUMBER THAT REPORTED DATA
African Region	47	46	47	46
Region of the Americas	45	39	35	32
South-East Asia Region	11	11	11	11
European Region	54	44	53	43
Eastern Mediterranean Region	22	21	21	20
Western Pacific Region	36	31	27	26
Global	**215**	**192**	**194**	**178**

Following review and follow-up with countries, the data used for the main part of this report were those that were available on **21 July 2023**. Table A2.1 shows the number of countries and territories that had reported data by 21 July 2023.

Indicators in the Sustainable Development Goals (SDGs) associated with TB incidence were imported into the global TB database on **4 July 2023**. Table A2.2 shows the data sources used.

Population estimates from the United Nations Population Division's 2022 revision of World Population Prospects[3] were imported into the global TB database on 2 August 2022 and used in the analyses for this report.

A2.2 Accessing TB data using the WHO website

Most of the data held in the WHO global TB database can be accessed via the WHO TB data web page.[4] This page provides comma-separated value (CSV) data files and data visualizations, as well as country, regional and global profiles (Annex 4).

Data reported by countries, such as time series for

[1] https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

[2] https://extranet.who.int/tme

[3] https://population.un.org/wpp/

[4] https://www.who.int/teams/global-tuberculosis-programme/data

TABLE A2.2

Data sources for indicators in the Sustainable Development Goals associated with TB incidence

SDG INDICATOR	DISPLAY NAME IN PROFILE	DATA SOURCE	NAME AT SOURCE	SOURCE URL
1.1.1	Population living below the international poverty line (% of population)	UN SDG database	Proportion of population below the international poverty line of US$1.90 per day	https://unstats.un.org/SDGAPI/v1/sdg/Series/Data?seriesCode=SI_POV_DAY1
1.3.1	Population covered by social protection floors/systems (% of population)	World Bank	Coverage of social protection and labor programs (% of population)	http://data.worldbank.org/indicator/per_allsp.cov_pop_tot
2.1.1	Prevalence of undernourishment (% of population)	World Bank	Prevalence of undernourishment (% of population)	http://data.worldbank.org/indicator/SN.ITK.DEFC.ZS
3.3.1 *(alternative)*	HIV prevalence (% of population aged 15-49 years)	WHO-GHO	Prevalence of HIV among adults aged 15 to 49 (%)	https://ghoapi.azureedge.net/api/MDG_0000000029
3.4.1 *(alternative)*	Diabetes prevalence (% of population aged ≥ 18 years)	WHO-GHO	Raised fasting blood glucose (≥7.0 mmol/L or on medication) (age-standardized estimate)	https://ghoapi.azureedge.net/api/NCD_GLUC_04
3.5.2 *(alternative)*	Alcohol use disorders, 12 month prevalence (% of population aged ≥ 15 years)	WHO-GHO	Alcohol use disorders (15+), 12 month prevalence (%) with 95%	https://ghoapi.azureedge.net/api/SA_0000001462
3.a.1 *(alternative)*	Smoking prevalence (% of population aged ≥ 15 years)	WHO-GHO	Estimate of current tobacco smoking prevalence (%) (age-standardized rate)	https://ghoapi.azureedge.net/api/M_Est_smk_curr_std
3.8.1	UHC index of essential service coverage (based on 14 tracer indicators including TB treatment)	WHO-GHO	UHC index of essential service coverage	https://ghoapi.azureedge.net/api/UHC_INDEX_REPORTED
3.8.2	Greater than 10% of total household expenditure or income on health (% of population)	WHO-GHO	Catastrophic out-of-pocket health spending (SDG indicator 3.8.2)	https://ghoapi.azureedge.net/api/FINPROTECTION_CATA_TOT_10_POP
3.8.2 *(alternative)*	Health expenditure per capita, PPP (current international $)	World Bank	Current health expenditure per capita, PPP (current international $)	http://data.worldbank.org/indicator/SH.XPD.CHEX.PP.CD
7.1.2	Access to clean fuels and technologies for cooking (% of population)	World Bank	Access to clean fuels and technologies for cooking (% of population)	http://data.worldbank.org/indicator/EG.CFT.ACCS.ZS
8.1.1 *(alternative)*	GDP per capita, PPP (constant 2011 international $)	World Bank	GDP per capita, PPP (constant 2011 international $)	http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD
10.1.1 *(alternative)*	GINI index (0=perfect equality, 100=perfect inequality)	World Bank	GINI index (World Bank estimate)	http://data.worldbank.org/indicator/SI.POV.GINI
11.1.1	Population living in slums (% of urban population)	UN SDG database	Proportion of urban population living in slums (%)	https://unstats.un.org/SDGAPI/v1/sdg/Series/Data?seriesCode=EN_LND_SLUM

case notifications and treatment outcomes, and WHO's estimates of TB disease burden, can be downloaded as CSV files covering all years for which data are available. They can be imported into many applications such as spreadsheets, databases and statistical analysis software. These files are the primary resource for anyone interested in conducting their own analyses of the records in the global TB database. A data dictionary that defines each of the variables available in the CSV files is also available.

The CSV files are generated on demand directly from the WHO global TB database, and may therefore include updates received after publication of the *Global tuberculosis report 2023*.

A2.3 Accessing TB data using the WHO Global Health Observatory

The WHO Global Health Observatory (GHO)[1] is a portal that provides access to data and analyses for monitoring the global health situation; it includes a data repository.

Data from WHO's global TB database can be viewed, filtered, aggregated and downloaded from within the GHO data repository.[2]

There is also an application programme interface (API)[3] using the open data protocol. The API allows analysts and programmers to use GHO data directly in their software applications.

[1] https://www.who.int/data/gho
[2] https://www.who.int/data/gho/data/themes/tuberculosis
[3] https://www.who.int/data/gho/info/gho-odata-api

ANNEX 3

WHO global lists of high TB burden countries

A3.1 Background

During the period 1998 to 2015, the concept of a "high burden country" (HBC) became familiar and widely used in the context of tuberculosis (TB). The first global list developed by the World Health Organization (WHO) consisted of 22 HBCs with approximately 80% of the world's TB cases; this was established in 1998. Subsequently two other HBC lists, for HIV-associated TB and multidrug-resistant TB (MDR-TB), were defined.

In 2015, three WHO global lists of HBCs – for TB, TB/HIV and MDR-TB – were in use. With a new era of the United Nations (UN) Sustainable Development Goals (SDGs) and the WHO End TB Strategy starting in 2016, a thorough review of the three lists was undertaken by the WHO Global Tuberculosis Programme in 2015 *(1)*. This included consideration of whether the lists should be modified (and if so how) or whether they should be discontinued. The outcome of the review was the definition of three new global HBC lists, of 30 countries each, for the period 2016–2020: one for TB, one for TB/HIV and one for MDR-TB.

WHO conducted a consultation process in 2020 and early 2021, as the basis for defining updated global HBC lists for 2021–2025.

A3.2 Global HBC lists to be used by WHO, 2021–2025

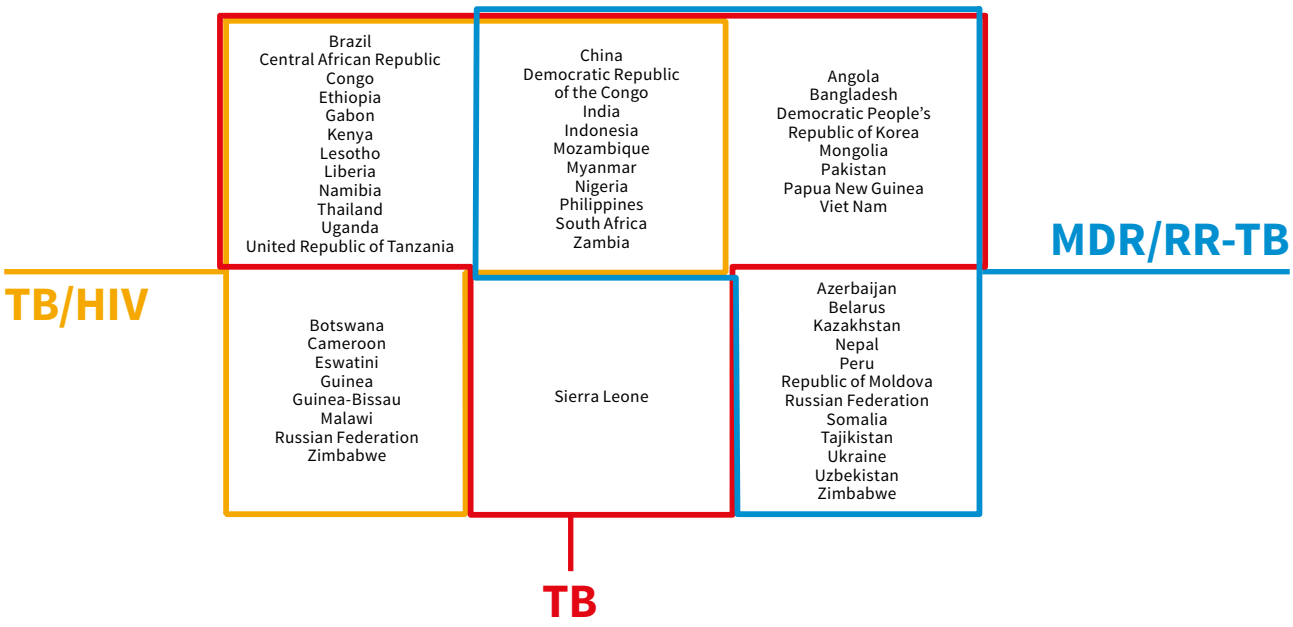
Three global HBC lists for 2021–2025 have been established: one for TB, one for HIV-associated TB and one for MDR/rifampicin-resistant TB (MDR/RR-TB). The lists were defined using the same criteria as those agreed for the 2016–2020 lists, in combination with the WHO estimates (for 2019) of the incidence of TB, HIV-associated TB and rifampicin-resistant TB that were published in WHO's *Global Tuberculosis Report 2020*. Full details are available in a background document *(2)*.

The criteria for all three lists are the same:

- the top 20 countries in terms of their estimated absolute number of new (incident) cases in 2019; plus
- the 10 countries with the most severe burden in terms of the incidence rate (new cases per 100 000 popula-

FIG. A3.1

The three global lists of high-burden countries for TB, HIV-associated TB and MDR/RR-TB to be used by WHO in the period 2021–2025, and their areas of overlap



tion in 2019) that are not already in the top 20, and that meet a minimum threshold in terms of their absolute number of cases. The thresholds are 10 000 new cases per year for TB; and 1000 new cases per year for HIV-associated TB and rifampicin-resistant TB.

The 30 countries that are in each of the three lists are shown in **Fig. A3.1** and **Table A3.1**. There is overlap among the three lists, but 49 countries are in at least one of them. Each list accounted for 86–90% of the estimated global incidence in 2019.

The main changes compared with the previous lists for 2016–2020 are:

- **The 30 high TB burden countries.** Cambodia, the Russian Federation and Zimbabwe transitioned out of the list; Gabon, Mongolia and Uganda joined the list.
- **The 30 high TB/HIV burden countries.** Angola, Chad, Ghana and Papua New Guinea transitioned out of the list; Gabon, Guinea, Philippines and the Russian Federation joined the list.
- **The 30 high MDR/RR-TB burden countries.** Ethiopia, Kenya and Thailand transitioned out of the list; Mongolia, Nepal and Zambia joined the list.

The lists provide a focus for global action on TB, HIV-associated TB and drug-resistant TB in the countries where progress is most needed to achieve the targets set in WHO's End TB Strategy, the political declaration of the UN high-level meeting on TB held in 2018 and the UN SDGs (**Table 1**). They also help to build and sustain national political commitment and funding in the countries with the highest burden in terms of absolute numbers or severity and promote global monitoring of progress in a well-defined set of countries.

The 30 high TB burden countries are given particular attention in the report. Where estimates of disease burden and assessment of progress in the response are for HIV-associated TB or MDR/RR-TB specifically, the countries in the other two lists are given particular attention. Country profiles for all countries are available online, including in the mobile app that accompanies the report (**Annex 4**).

A3.3 Global TB watchlist

Alongside the three updated global HBC lists, WHO has established a "global TB watchlist". This consists of the three countries that exited the global list of 30 high TB burden countries in 2021, but which nonetheless warrant continued attention and will remain a priority in terms of support from WHO. The three countries in the watchlist are Cambodia, the Russian Federation and Zimbabwe.

TABLE A3.1

Countries in the three global lists of high-burden countries for TB, HIV-associated TB and MDR/RR-TB to be used by WHO in the period 2021–2025.

The red square indicates that a country is in a list.

COUNTRY	TB	TB/HIV	MDR/ RR-TB
Angola	■		■
Azerbaijan			■
Bangladesh	■		■
Belarus			■
Botswana		■	
Brazil	■	■	
Cameroon		■	
Central African Republic	■	■	
China	■	■	■
Congo	■	■	
Democratic People's Republic of Korea	■		■
Democratic Republic of the Congo	■	■	■
Eswatini		■	
Ethiopia	■	■	
Gabon	■	■	
Guinea		■	
Guinea-Bissau		■	
India	■	■	■
Indonesia	■	■	■
Kazakhstan			■
Kenya	■	■	
Kyrgyzstan			■
Lesotho	■	■	
Liberia	■	■	
Malawi		■	
Mongolia	■		■
Mozambique	■	■	■
Myanmar	■	■	■
Namibia	■	■	
Nepal			■
Nigeria	■	■	■
Pakistan	■		■
Papua New Guinea	■		■
Peru			■
Philippines	■	■	■
Republic of Moldova			■
Russian Federation		■	■
Sierra Leone	■		
Somalia			■
South Africa	■	■	■
Tajikistan			■
Thailand	■	■	
Uganda	■	■	
Ukraine			■
United Republic of Tanzania	■	■	
Uzbekistan			■
Viet Nam	■		■
Zambia	■	■	■
Zimbabwe		■	■

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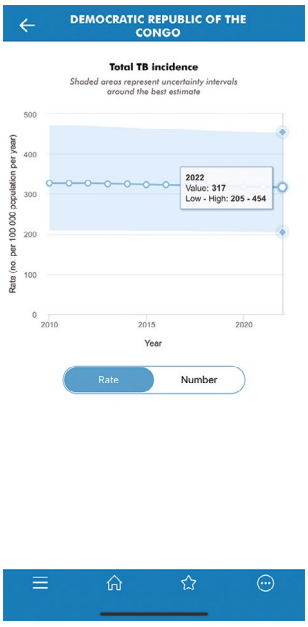
ANNEX 4

Country, regional and global profiles

Country, regional and global profiles as well as data for all key indicators for all countries and areas are available in the WHO Global Tuberculosis Report mobile app and on the tuberculosis (TB) Data web page.[1]

A4.1 The WHO Global TB Report mobile app

The free WHO Global TB Report mobile app includes country, regional and global profiles from the WHO global TB database, as well as a summary of the key facts and messages from the report and an overview of progress towards global TB targets. The app allows users to easily view, query and visualize data, and to define queries, including those for specific country groups. Once installed, the app works offline so that data can be accessed without an ongoing internet connection. The app is available for Android devices through Google Play and for iOS devices, such as iPhones and iPads, through the Apple Store.[2,3] It is available in English, French, Spanish and Russian.



A4.2 Online country profiles and other reports

TB data profiles are available online for all 215 countries and areas that report TB data to WHO each year, as are aggregate profiles for WHO regions and globally.[1] The profiles are available in English, French, Spanish and Russian. They are generated on-demand directly from the WHO global TB database (**Annex 2**) and may therefore include updates received after publication of the global TB report. Estimates of TB cases attributable to five risk factors and indicators in the Sustainable Development Goals (SDGs) that are associated with TB incidence are available for all 215 countries and territories. TB financial profiles are available for more than 100 countries and territories that report detailed TB financial data to WHO.

[1] https://www.who.int/teams/global-tuberculosis-programme/data

[2] https://play.google.com/store/apps/details?id=uk.co.adappt.whotbreport

[3] https://apps.apple.com/us/app/tb-report/id1483112411

ANNEX 5

Updates to estimates of TB disease burden

The report includes estimates of tuberculosis (TB) incidence and mortality for the period 2010–2022; estimates of TB incidence and mortality, disaggregated by age and sex, for 2022; and estimates of the incidence of rifampicin-resistant TB (RR-TB) for the period 2015–2022. This annex summarizes the main updates to the methods used to produce these estimates and the resulting estimates that are presented in the report, compared with the *Global tuberculosis report 2022 (1, 2)*. Details are provided in the technical appendix.

There were four major updates to estimates for this report:

- **Time period for which estimates are presented.** The start year for the time series of TB incidence and mortality estimates was changed from 2000 to 2010.
- **Estimates for India.** Estimates of TB incidence and mortality were updated for the period 2010–2019, with a major revision to estimates of TB mortality. These updates led in turn to updates to previously published estimates for 2020–2021 *(1)*.
- **Country-specific dynamic models.** Use of such models to estimate TB incidence and mortality during the COVID-19 pandemic (and its aftermath) was expanded to include three additional countries and dropped for one country.
- **Estimates of the incidence of RR-TB.** Estimates of the proportion of new and previously treated TB cases with RR-TB in the period 2015–2021 were updated for some countries, based on new or corrected data. For all countries, the time series was extended to cover 2015–2022 rather than 2015–2021.

A5.1 Time period for which estimates are presented

The report presents estimates of TB incidence and mortality for the period 2010–2022. The first year of the time series was changed to 2010 (instead of 2000). Thus, the estimates cover a shorter period before the start of the World Health Organization (WHO) End TB Strategy and United Nations (UN) Sustainable Development Goals (SDGs) and give greater emphasis to the periods covered by the strategy (2016–2035) and the SDGs (2016–2030), up to the most recent complete calendar year. The baseline year for the milestones and targets set in the End TB Strategy is 2015.[1]

[1] See **Box 2** in the main report.

A5.2 Estimates for India

There was a major revision to estimates of TB mortality in the period 2010–2019, following the recent publication of cause-of-death data from the country's Sample Registration System (SRS) for the period 2014–2019 *(3–6)*. There was a minor revision (a slight upward adjustment) to TB incidence estimates, following a thorough review of the country-specific model that was used in 2022 to produce "interim" estimates and the incorporation of new data in this model. Both revisions followed several months of joint work by WHO, India's Ministry of Health & Family Welfare and modelling experts from academic institutions (within and outside India).

The country-specific model used for TB incidence estimates in the period 2010–2019 was developed as a collaboration between the National TB Elimination Programme in the Ministry of Health & Family Welfare, the WHO Country Office for India and the Indian Council for Medical Research. This model was used in combination with the WHO country-specific dynamic model that was developed to estimate TB incidence and mortality in India during the COVID-19 pandemic and its aftermath (see also **Section A5.3**).

The revisions to TB mortality estimates are highlighted and explained in more detail in **Box 4** in the main report. Further details about updates to TB incidence estimates are provided in the technical appendix.

A5.3 Country-specific dynamic models

Country-specific models were first developed in 2021. This was necessary to ensure that estimates of TB incidence and mortality in 2020 accounted for the impact of COVID-related disruptions on TB diagnosis and treatment. Such impacts were evident in large absolute reductions in TB case notifications (relative to pre-pandemic trends) in some countries. These reductions were interpreted as being due to reduced detection of people with TB, which in turn resulted in an increase in the number of people in the community with undiagnosed and untreated TB.

In 2022, to produce estimates of TB incidence and mortality in 2020 and 2021, country-specific models were used for 24 countries. In 2023, to produce estimates in the period 2020–2022, these models were retained for use in 23 countries, no longer used for Papua New Guinea and expanded to cover Afghanistan,

Ukraine and Uzbekistan.[1] Thus, in 2023, country-specific models were used for a total of 26 countries.

The model-based estimates of TB mortality were not used for four countries that reported national vital registration (VR) data on causes of death (including for TB specifically) for the period 2020–2022 to WHO: Azerbaijan, Brazil, Kazakhstan and Ukraine.

The country-specific models were extensively reviewed in 2021 and 2022; details about both the models and the reviews are available elsewhere *(7, 8)*. From February to June 2023, the models were further informed by a series of in-depth bilateral discussions with 13 countries: Afghanistan, Brazil, Cambodia, Indonesia, Kazakhstan, Kyrgyzstan, Lesotho, Malaysia, Pakistan, the Philippines, Thailand, Uzbekistan and Viet Nam. These discussions were used to identify any new information available at country level to inform model inputs and to make associated model adjustments (e.g. to the estimated level of underreporting during COVID-19 disruptions). Generally, these adjustments resulted in downward revisions to estimates of TB incidence in the period 2020–2021.

A5.4 RR-TB incidence estimates

In 2022, new methods were developed to produce time series of estimates at country, regional and global levels for the first time, covering the period 2015–2021 *(1, 2)*. These methods have been described in detail elsewhere and were extensively discussed and reviewed. For this report, the same methods were used to produce time series for 2015–2022.

Two of the key inputs to RR-TB incidence estimates are estimates of a) the proportion of new TB cases that have RR-TB and b) the proportion of previously treated TB cases that have RR-TB *(1, 2, 7)*. For this report, estimates of these proportions in 2022 and in previous years were used, and estimates for years before 2022 were revised for some countries based on updated or corrected data. These revisions included a major update to estimates of the proportion of people in Pakistan newly diagnosed with TB (and with no previous history of TB treatment) who have RR-TB, for which there was a large downward revision (from 5.9% in 2021 to 2.3% in 2022), based on updated subnational surveillance data reported to WHO. This update resulted in a downward revision to the estimated annual incidence of RR-TB in Pakistan of about 20 000.

A third key input to RR-TB incidence estimates is the estimated level of TB incidence overall *(1, 2, 7)*. Downward revisions to overall estimates of TB incidence in some of the countries for which country-specific models were used for the period 2020–2022 (**Section A5.3** above) resulted in lower estimates of RR-TB incidence in these countries.

As a result of the downward revision to the estimated proportion of new TB cases in Pakistan that have RR-TB and the downward revisions to overall estimates of TB incidence in some countries, current global estimates of RR-TB incidence in 2020–2021 are lower than those published in 2022 *(1)*.

A5.5 Other miscellaneous updates

New data on TB mortality were reported to WHO between mid-2020 and mid-2021. Several countries either reported historical data that were previously missing or corrected previously reported data. Updated estimates of HIV prevalence and mortality were obtained from the Joint UN Programme on HIV/AIDS (UNAIDS) in July 2023.

A new inventory study was completed in China in 2022. Results from this study were shared with WHO in July 2023 and used to estimate TB incidence in China in 2022.

A5.6 More information about methods used for all countries

Details about the methods used for all countries, with a clear distinction between the time periods 2010–2019 and 2020–2022, are provided in the report webpages (**Section 1.1** and **Section 1.2**)[2] and in the technical appendix.

The main data sources currently available to inform estimates of TB disease burden in the 30 high TB burden countries and three global TB watchlist countries (**Annex 3**) are summarized in **Table A5.1**.

[1] A country model was no longer used in Papua New Guinea to avoid a discontinuity with the previous (flat) trend estimated for the period 2010–2019. Development of country-specific models for the three new countries followed a careful review of their case notification data for 2020–2022, which showed reductions during the COVID-19 pandemic (compared with pre-pandemic trends).

[2] In particular, see **Box 1.1.1** in **Section 1.1** and **Box 1.2.1** in **Section 1.2**.

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TABLE A5.1

Sources of data available to inform estimates of TB disease burden in the 30 high TB burden countries and the 3 global TB watchlist countries, 2010-2022.[a] Blue indicates that a source is available, orange indicates it will be available in the near future, and red indicates that a source is not available.

COUNTRY	NOTIFICATION DATA	STANDARDS AND BENCHMARK ASSESSMENT[b]	NATIONAL INVENTORY STUDY[c]	NATIONAL TB PREVALENCE SURVEY[d]	NATIONAL DRUG RESISTANCE SURVEY OR SURVEILLANCE[e]	NATIONAL VR DATA OR MORTALITY SURVEY[f]
Angola	2000–2022	2019, 2023	–	–	*2022*	–
Bangladesh	2000–2022	2019, 2023	–	2015	2011, 2019	–
Brazil	2000–2022	2018	–	NA	2008	2000–2022
Cambodia	2000–2022	2018, 2022	–	2002, 2011	2001, 2008, 2017	[g]
Central African Republic	2000–2022	2019, 2022	–	–	2009	–
China	2000–2022	–	2018, 2022	2000, 2010	2007, 2013, *2020*, *2022*	2004–2021
Congo	2000–2022	2019, 2022	–	–	–	
Democratic People's Republic of Korea	2000–2022	2017	–	2016	2014	
Democratic Republic of the Congo	2000–2022	2019, 2022	–	–	2017	–
Ethiopia	2000–2022	2016, 2023	–	2011	2005, 2018, *2018*, *2020*	–
Gabon	2000–2022	2018, 2020	–	–	–	–
India	2000–2022	2019	2016	2019–2021	2016, *2020*	2000–2019
Indonesia	2000–2022	2019, 2022	2017 2023	2013–2014	2018	2006–2007, 2009–2015
Kenya	2000–2022	2017, 2021	2013	2015	2014, 2020	–
Lesotho	2000–2022	2017, 2022	–	2019	2014, *2019–2022*	–
Liberia	2000–2022	2015, 2019	–	–	–	–
Mongolia	2000–2022	2015, 2018	2023	2014–2015	2007, 2016, *2018–2022*	2016–2019
Mozambique	2000–2022	2013	–	2017–2019	2007, 2022, *2021–2022*	–
Myanmar	2000–2022	2017, 2023	–	2009, 2018	2003, 2008, 2013, *2018*, *2020*	–
Namibia	2000–2022	2019, 2022	–	2017–2018	2008, 2015, 2018, *2020–2022*	
Nigeria	2000–2022	2020, 2023	–	2012	2010, *2022*	–
Pakistan	2000–2022	2019, 2022	2012, 2017	2011	2013, *2019–2020*	2006, 2007, 2010
Papua New Guinea	2000–2022	2017	–	–	2014, *2019–2020*	–
Philippines	2000–2022	2016, 2019	2023	2007, 2016	2004, 2012, 2019, *2021–2022*	2000–2014, 2016–2019
Russian Federation	2000–2022	2017	–	NA	*2016–2022*	2000–2022
Sierra Leone	2000–2022	2015, 2020	–	–	–	–
South Africa	2000–2022	2019, 2022	2022	2017–2019	2002, 2014, *2021–2022*	2000–2017
Thailand	2000–2022	2013	–	2012	2001, 2006, 2012, 2018	2000, 2002–2019
Uganda	2000–2022	2019, 2022	–	2014–2015	2011, *2018–2019*	–
United Republic of Tanzania	2000–2022	2018, 2023	–	2012	2007, 2018, *2021–2022*	–
Viet Nam	2000–2022	2019, 2023	2017	2007, 2017–2018	2006, 2012, *2018*, *2020–2022*	–
Zambia	2000–2022	2016, 2020	–	2014	2000, 2008, 2020, *2018–2021*	–
Zimbabwe	2000–2022	2019, 2022	–	2014	2016, *2018–2020*, *2022*	–

NA, not applicable; VR, vital registration

[a] Data for the period 2000–2009 can inform estimates for the period 2010–2022 and are shown for this reason. The 3 global TB watchlist countries are Cambodia, Russian Federation and Zimbabwe.

[b] The WHO TB surveillance checklist of standards and benchmarks is designed to assess the quality and coverage of notification data (based on 9 core standards), VR data (1 standard) and drug-resistant TB, HIV co-infection and childhood TB (3 supplementary standards). A partial assessment has been done in China. If more than two assessments have been done, the years of the last two only are shown.

[c] An inventory study is currently underway in Indonesia and South Africa. Studies are planned in Mongolia in 2023 and the Philippines for 2023–2024. Prioritization of TB inventory studies is recommended in countries where a large share of TB care is provided to people with TB outside the existing NTP network.

[d] Brazil does not meet the following criteria recommended by the WHO Global Task Force on TB Impact Measurement for implementing a national prevalence survey: TB incidence ≥150 per 100 000 population per year, no vital registration system and under-5 mortality rate (probability of dying by age of 5 per 1000 live births) is >10.

[e] Data points are shown for people without history of previous TB treatment only. Data are available from continuous surveillance (indicated by italics in blue cell) based on routine diagnostic testing in Angola, China, Ethiopia, India, Kenya, Lesotho, Mongolia, Mozambique, Myanmar, Namibia, Pakistan (subnational only), Philippines, South Africa, Uganda, United Republic of Tanzania, Viet Nam, Zambia and Zimbabwe.

[f] Years of data availability for Indonesia, Mongolia, Pakistan and South Africa were provided to WHO by IHME.

[g] Input data used to inform the covariates for estimating TB mortality in Cambodia available here: Ma, J., Vongpradith, A., Ledesma, J.R. et al. Progress towards the 2020 milestones of the end TB strategy in Cambodia: estimates of age and sex specific TB incidence and mortality from the Global Burden of Disease Study 2019. BMC Infect Dis 22, 904 (2022). https://doi.org/10.1186/s12879-022-07891-5.

ANNEX 6

The WHO TB-SDG monitoring framework

In 2017, the World Health Organization (WHO) developed a framework for monitoring of indicators in the United Nations (UN) Sustainable Development Goals (SDGs) that are strongly associated with tuberculosis (TB) incidence. This was done as part of the preparations for the first global ministerial conference on TB *(1)*, building on previously published work that identified clear linkages between a range of social, economic and health-related indicators and TB incidence *(2–5)*.

The TB-SDG monitoring framework comprises 14 indicators under seven SDGs (**Table A6.1**).

For SDG 3, the framework includes seven indicators:

- coverage of essential health services;
- proportion of the population with large household expenditures on health as a share of total household expenditure or income;
- current health expenditure per capita;
- HIV prevalence;
- prevalence of smoking;
- prevalence of diabetes; and
- prevalence of alcohol use disorders.

For SDGs 1, 2, 7, 8, 10 and 11, the seven indicators selected for monitoring are:

- proportion of the population living below the international poverty line;
- proportion of the population covered by social protection floors or systems;
- prevalence of undernourishment;
- proportion of the population with primary reliance on clean fuels and technology;
- gross domestic product (GDP) per capita;
- Gini index for income inequality; and
- proportion of the urban population living in slums.

Collection and reporting of data for the 14 indicators does not require any additional data collection and reporting efforts by national TB programmes (NTPs). Nor does it require data collection and reporting efforts that go beyond those to which countries have already committed in the context of the SDGs. At the global level, the UN has established a monitoring system for SDG indicators, and countries are expected to report data on an annual basis via the appropriate UN agencies (including WHO). Therefore, analysis of the status of, and trends in, the 14 indicators related to TB can be based primarily on data held in the UN's SDG database.

In some cases, the official SDG indicator was not considered the best metric, and a better (but closely related) alternative was identified and justified (five indicators under SDG 3, one under SDG 8 and one under SDG 10). In such cases, the data sources are one of the following: WHO, the Organisation for Economic Co-operation and Development (OECD), the Joint United Nations Programme on HIV/AIDS (UNAIDS) or the World Bank.

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TABLE A6.1

TB-SDG monitoring framework: indicators to monitor within SDG 3

SDG 3: Ensure healthy lives and promote well-being for all at all ages					
SDG TARGETS FOR 2030	SDG INDICATORS	ALTERNATIVE INDICATORS TO MONITOR	RATIONALE	DATA SOURCE	COLLECT DATA FOR TB PATIENTS SPECIFICALLY?
3.3 End the epidemics of AIDS, TB, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	**3.3.1** Number of new HIV infections per 1000 uninfected population **3.3.2** TB incidence per 100 000 population	HIV prevalence	HIV is a strong risk factor for development of TB disease and is associated with poorer treatment outcomes. HIV prevalence is selected in preference to HIV incidence because it is directly measured.	UNAIDS WHO	Yes, already routinely collected. NA
3.4 Reduce premature mortality by one third from non-communicable diseases and promote mental health and well-being	**3.4.1** Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease	Prevalence of diabetes	Diabetes is a strong risk factor for development of TB disease, although a link with TB incidence at the national (as opposed to individual) level has been difficult to establish due to confounding. Diabetes prevalence is more relevant than mortality for TB since it directly influences the risk of developing TB.	WHO	Could be considered at country level, to inform planning of care for comorbidities.
3.5 Strengthen prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	**3.5.2** Alcohol consumption per capita per year (in litres of pure alcohol) among those aged ≥15 years (harmful level defined nationally)	Prevalence of alcohol use disorders	Alcohol use is a strong risk factor for TB disease and poorer treatment outcomes at the individual level, although a link with TB incidence at the national (as opposed to individual) level has been hard to establish due to confounding. The prevalence of alcohol use disorders is the most relevant indicator in the context of TB.	WHO	Could be considered at country level, to inform planning of care for comorbidities.
3.8 Achieve Universal Health Coverage (UHC), including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	**3.8.1** Coverage of essential health services (defined as the average coverage of essential services based on 16 tracer interventions). **3.8.2** Proportion of population with large household expenditures on health as a share of total household expenditure or income	NA NA	Achieving UHC is required to achieve the three high-level targets of the End TB Strategy for reductions in the TB incidence rate, reductions in the number of TB deaths and elimination of catastrophic costs for TB patients and their households. TB treatment coverage has been monitored for years and is one of the 16 tracer indicators that have been selected to measure SDG indicator 3.8.1.	WHO	No
3.a Strengthen implementation of the WHO Framework Convention on Tobacco Control	**3.a.1** Age-standardized prevalence of current tobacco use among those aged ≥15 years	Prevalence of smoking among those aged ≥15 years (%)	Smoking is a strong risk factor for TB disease at the individual level, although a link with TB incidence at the national (as opposed to individual) level has been difficult to establish due to confounding.	WHO	Could be considered (e.g. to inform access to smoking cessation interventions).
3.c Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States	**3.c.1** Health worker density and distribution	Current health expenditure per capita	Health expenditure per capita is negatively correlated with TB incidence.	WHO	No

AIDS, acquired immune deficiency syndrome; HIV, human immunodeficiency virus; NA, not applicable; SDG, Sustainable Development Goal; TB, tuberculosis; UHC, universal health coverage; UNAIDS, Joint United Nations Programme on HIV/AIDS; WHO, World Health Organization

TB-SDG monitoring framework: indicators to monitor beyond SDG 3

SDG TARGETS FOR 2030	SDG INDICATORS	ALTERNATIVE INDICATORS TO MONITOR	RATIONALE	DATA SOURCE	COLLECT DATA FOR TB PATIENTS SPECIFICALLY?
SDG 1: End poverty in all its forms everywhere					
1.1 Eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day	**1.1.1** Proportion of population living below the international poverty line	NA	Poverty is a strong risk factor for TB, operating through several pathways. Reducing poverty should also facilitate prompt health-care seeking. Countries with higher levels of social protection have lower TB burden. Progress on both indicators will help to achieve the End TB Strategy target to eliminate catastrophic costs for TB patients and their households.	UN SDG database, World Bank	No
1.3 Implement nationally appropriate social protection systems and measures for all, including floors, and achieve substantial coverage of the poor and vulnerable	**1.3.1** Proportion of population covered by social protection floors/systems	NA			Could be considered (e.g. to facilitate access to social protection).
SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture					
2.1 End hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food year-round	**2.1.1** Prevalence of undernourishment	NA	Undernutrition weakens the body's defence against infections and is a strong risk factor for TB at the national and individual level.	UN SDG database	Could be considered (e.g. to plan food support).
SDG 7: Ensure access to affordable, reliable, sustainable, and modern energy for all					
7.1 Ensure universal access to affordable, reliable and modern energy services	**7.1.2** Proportion of population with primary reliance on clean fuels and technology	NA	Indoor air pollution is a risk factor for TB disease at the individual level. There has been limited study of ambient air pollution but it is plausible that it is linked to TB incidence.	WHO	No
SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all					
8.1 Sustain per capita growth in accordance with national circumstances and, in particular, at least 7% GDP growth per year in the least developed countries	**8.1.1** Annual growth rate of real GDP per capita	GDP per capita	Historic trends in TB incidence are closely correlated with changes in the absolute level of GDP per capita (but not with the growth rate).	World Bank	No
SDG 10: Reduce inequality within and among countries					
10.1 Achieve and sustain income growth of the bottom 40% of the population at a rate higher than the national average	**10.1.1** Growth rates of household expenditure or income per capita, overall and for the bottom 40% of the population	Gini index for income inequality	TB is a disease of poverty. Decreasing income inequalities combined with economic growth should have an effect on the TB epidemic.	World Bank OECD	No
SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable					
11.1 Ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	**11.1.1** Proportion of urban population living in slums, informal settlements or inadequate housing	NA	Living in a slum is a risk factor for TB transmission due to its link with overcrowding. It is also a risk factor for developing TB disease, due to links with air pollution and undernutrition.	UN SDG database	No

GDP, gross domestic product; NA, not applicable; OECD, Organisation for Economic Co-operation and Development; SDG, Sustainable Development Goal; TB, tuberculosis; UN, United Nations; WHO, World Health Organization.

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