National TB Prevalence Surveys: are they still relevant for estimation of TB disease burden in the period 2025–2030?

Background document 3

for meeting of

WHO Global Task Force on

TB Impact Measurement,

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Developed by:
Katherine Floyd, Irwin Law,
Nim Arinaminpathy, Mathieu Bastard

Questions to inform review & discussion

1. Are national TB prevalence surveys in the period 2025–2030 still relevant to inform estimates of TB disease burden?

   Yes/No/Not sure

   Please give reasons for your answer.

2. If Yes:

   In which of the following two categories of country do you think they are **most** relevant in terms of assessment of whether (or to what extent) the 2025 milestone and 2030 target for incidence[1] are met?

   a) Countries that have already completed at least one survey and that meet both epidemiological and feasibility criteria (as defined in section 4)
   b) Countries that have not previously implemented a survey but meet both epidemiological and feasibility criteria (as defined in section 4)

   For your selected category, what criteria could be used to identify countries that are particularly high priorities for implementing a survey between 2025 and 2030, from a global perspective? (NB: For category A, please see Table 6).

3. If No:

   For the 29 countries for which the main source of data currently used to inform WHO estimates of TB incidence is a national TB prevalence survey, what alternative(s) to a repeat survey would you propose for assessment of trends in the period between the last survey and 2030?

   a) National TB inventory study in the period 2025–2030
   b) Case notification data combined with expert opinion about case detection gaps, for selected years
   c) Use of data from active case finding activities covering the general population
   d) Use of data from active case finding activities focused on target populations
   e) Use of case notification data combined with an upward adjustment based on the UHC service coverage index
   f) Estimation of trends using routinely available programmatic data (please specify what these data would be)
   g) Other (if selected, please define what this would be)

   Please give reasons for your selected choice(s).

4. If not sure:

   What additional information would you need to decide?

[1] A 50% and 80% reduction in incidence by 2025 and 2030 respectively, compared with 2015 levels.

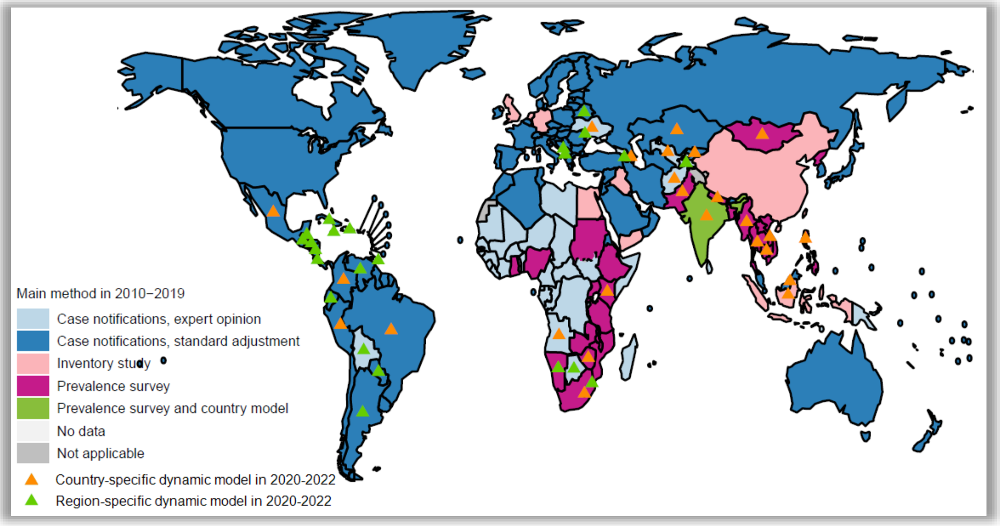
Contents

1. Introduction

National TB prevalence surveys are currently a major source of data used by WHO to produce estimates of TB incidence. In the Global TB Report 2023 *(1)*, survey data were the main data source used for 29 countries[1] that collectively accounted for 66% of the world's estimated number of incident cases in 2022 (**Fig. 1**; see countries in purple and green).

WHO's use of prevalence survey data for TB disease burden estimation has grown considerably in the last 15 years, a period in which many countries implemented a survey for the first time. In 2010, for example, prevalence survey data were only used for five countries: Cambodia, China, Myanmar, the Philippines and Viet Nam. The growing availability of prevalence survey data enabled a shift away from burden estimates that relied primarily on case notification data and expert opinion about case detection gaps to estimates grounded in direct, population-based measurements of TB disease burden.

Fig. 1 Main data sources and analytical methods used to produce the estimates of TB incidence that were published in the Global TB report 2023, which covered the period 2010–2022



The main global surge in implementation of national TB prevalence surveys occurred between 2010 and 2017. Surveys are recommended approximately every 10 years and as the time since a country's last survey grows, it is becoming more difficult to reliably estimate the current level of TB disease burden (in the absence of other data that provide reliable evidence about trends since the last survey). This is especially the case for countries that suffered large disruptions to health services during the COVID-19 pandemic, for which dynamic models were required to produce estimates for 2020–2022 (**Fig. 1**).

For the 29 countries for which national TB prevalence surveys are the main data source used for estimation of TB incidence,[2] the question of how to reliably assess the current level of TB disease burden and whether this has changed since the last survey is therefore increasingly pressing, including for the purposes of assessing progress with respect to the 2025 milestone and 2030 target of the End TB Strategy. Since most of the 29 countries conducted their last prevalence survey in or in relatively close proximity to the 2015 baseline year of the Strategy, one option for direct assessment of the current level of TB disease burden and the change compared with 2015 is a repeat national TB prevalence survey in one of the years leading up to 2030. At the same time, there are concerns about surveys, including their financial cost (and the opportunity cost of using scarce resources for surveys), the time required to

[1] These countries are: Bangladesh, Cambodia, Eswatini, Ethiopia, Ghana, Gambia, India (in conjunction with a country-specific dynamic model), Kenya, Lao People's Democratic Republic, Lesotho, Malawi, Mongolia, Mozambique, Myanmar, Namibia, Nigeria, Nepal, Pakistan, the Philippines, Democratic People's Republic of Korea, Rwanda, Sudan, Thailand, United Republic of Tanzania, Uganda, Viet Nam, South Africa, Zambia and Zimbabwe.

[2] For more details about how prevalence survey data are used to produce estimates of TB incidence, including other data that are used to inform assessment of trends, see **Background document 1**.

implement them, and whether they produce an estimate that is, in practice, any better or more useful than estimates that could be produced more easily and at much lower cost.

This document explains the rationale for national TB prevalence surveys as well as their scope and design, and describes where they were implemented between 2007 and 2024. It then discusses in which countries they remain relevant based on epidemiological criteria while also highlighting non-epidemiological criteria that are a prerequisite for a survey to be feasible, the main concerns and associated questions about surveys that have been raised in recent years, what alternatives to surveys exist or are being explored, and which countries might be global priorities for repeat surveys in the years leading up to 2030.

2. Survey rationale, scope and design

The main purpose of a national TB prevalence survey is to measure the burden of TB disease in the population at a given point in time. Repeat surveys, usually after an interval of about 10 years, allow assessment of changes in burden over time (i.e. trends). Survey data also provide important insights that can help national TB programmes (NTPs) to identify ways to improve TB diagnosis and treatment, and to quantify and correct any underreporting of people diagnosed with TB through national disease surveillance systems *(2-5)*.

National TB prevalence surveys are not required to reliably measure the burden of TB disease and assess trends in all countries. Ideally, all countries should be able to reliably track their TB disease burden using national disease notification systems (to count the number of people developing TB disease each year) and national vital registration (VR) systems that include coding of causes of death according to international standards (to count the number of people who die from TB). Many countries already have high-quality disease notification and VR systems that cover a high percentage of the population and can be used for this purpose *(6, 7)*. However, there are many countries in which this is not yet possible.

In about 70 countries, including most of those with a high burden of TB disease, national disease notification systems do not yet provide reliable data about the number of people developing TB disease each year *(6, 8)*. This is for two reasons:

- There is underreporting of people diagnosed with TB, especially in countries with a large private sector or in which people with TB seek care in public facilities that are not linked to the NTP, and where notification of TB cases to national authorities is not mandatory; and
- There is underdiagnosis, especially in countries where there are geographical or financial barriers to accessing health care, or where there are health system gaps in terms of infrastructure, human resources and diagnostic facilities *(6, 9)*.

Similarly, many countries (about 90), including most of those with a high burden of TB disease, do not yet have national (or sample) VR systems in which there is high coverage and quality of cause-of-death registration *(7, 10)*.

In the absence of national disease notification and VR systems of high quality and coverage, national TB prevalence surveys provide an alternative way to directly measure the burden of TB disease in the population.[1]

National TB prevalence surveys typically focus on measuring the number of people aged 15 years and older who have bacteriologically confirmed pulmonary TB disease. This is in recognition of the limitations of available diagnostics, the realities of field operations and relatively low rates of TB disease (per 100 000 population) in children and young adolescents *(4, 5)*.[2,3] Results are then adjusted

[1] National TB inventory studies can be used to measure the level of underreporting; if certain (quite stringent) assumptions are met, they can also be used to estimate the level of underdiagnosis. For further explanation, see **Background document 1** and **section 6** (below).

[2] A definitive diagnosis of extrapulmonary TB often requires a biopsy or on-the-spot clinical expertise (or both). This is difficult to provide in the context of a population-based survey. Chest X-rays (CXRs) are not suitable for use in healthy children with a low risk of TB disease; it is difficult for children to produce sputum samples and the collection of other specimens (i.e. gastric aspirate or faecal samples) requires specific expertise and infrastructure; a precise estimate of the prevalence of TB disease in children would require a very large sample size.

[3] The diagnosis of TB in people with negative bacteriological test results typically requires follow-up investigations that are not logistically feasible in the context of a national TB prevalence survey.

to estimate the overall prevalence of TB disease in the whole population (for all ages and including extrapulmonary TB disease).

To identify people with bacteriologically confirmed pulmonary TB disease, the first step is to randomly sample geographical areas in the country (referred to as clusters). The number of clusters is defined according to the overall sample size and cluster size required to provide a precise estimate of the national prevalence of TB disease (a relative precision of 20–25%). Typically, an overall sample size of about 30 000–100 000 people and a cluster size of 400–800 people is required.[1] In the selected clusters, the eligible population (based on age and residency criteria) is identified through a household census; people are then screened for TB disease using a combination of a questionnaire about TB-related symptoms and a chest X-ray (CXR); those who screen positive through either means are tested for TB disease. In the third edition of WHO guidance on national TB prevalence surveys to be released in 2024, the main diagnostic algorithm that is recommended (referred to as "Option 1") is two Xpert Ultra tests[2] for everyone who screens positive on CXR or symptom questionnaire, followed by confirmatory testing using liquid culture for all those with at least one positive Xpert Ultra result.

3. Survey implementation, 2007–2024

The first national TB prevalence surveys were implemented in various countries in Africa and Asia in the 1950s, when there was a lack of evidence about the burden of TB disease in the population *(2, 4, 13)*. Between the 1960s and the end of the 1990s, further surveys were done in Asia, both to assess the burden of TB disease and (in countries where a series of surveys was done) to assess trends *(4)*. This included a series of surveys in Japan and the Republic of Korea.

Following a period in which only a small number of surveys were done, an unprecedented number of national TB prevalence surveys were implemented in a short period, between 2007 (when the first WHO guidance on prevalence surveys was published *(14)*) and 2017 (**Fig. 2**).

Fig. 2. Countries in which national TB prevalence surveys were implemented, 2007–2024
The year in which most field operations were implemented is shown. African countries are shown in **purple** and Asian countries in **green**.

2007	Philippines	Viet Nam			
2008	Bangladesh[a]				
2009	Myanmar				
2010	China				
2011	Cambodia	Ethiopia	Lao People's Democratic Republic	Pakistan	
2012	Gambia	Nigeria	Rwanda	United Republic of Tanzania	Thailand
2013	Malawi	Ghana	Sudan		
2014	Indonesia	Zambia	Zimbabwe		
2015	Bangladesh	Kenya	Mongolia	Uganda	
2016	Democratic People's Republic of Korea	Philippines			
2017	Mozambique	Myanmar	Namibia	South Africa	Viet Nam
2018	Eswatini	Nepal			
2019	Lesotho				
2020	India				
2021					
2022					
2023	Cambodia	Timor-Leste			

[a] The survey in Bangladesh (2008) collected sputum samples from all individuals (aged ≥15 years), but did not use CXR or a symptom questionnaire to screen individuals for sputum submission. Survey results were not considered reliable due to the implausibly low number of TB cases that were detected; experience from this survey (and an earlier one in Eritrea (2005) that used similar methods) informed an important update (in 2010) to WHO recommendations for the screening and diagnostic algorithm to use in surveys.

[1] Most other health-related surveys are of diseases and conditions with a much higher prevalence; hence, sample sizes can be much smaller.

[2] The guidance makes it clear that another molecular test of equivalent or better sensitivity could also be used. Currently, other molecular tests approved by WHO have lower sensitivity than Xpert Ultra. High sensitivity is important to ensure that people with TB disease are not missed during the screening process. Culture confirmation is required because of the specificity of Xpert Ultra (95% (93–97%) when trace results are considered positive, according to FIND evaluation data and a systematic review) *(11, 12)*.

In total, between 2007 and June 2024, 36 national surveys in 32 countries were implemented using the screening and diagnostic methods recommended by WHO. These included surveys in 20 of the 22 “global focus countries” that were identified as top global priorities for a survey in 2007 *(5)* and in 12 other countries. Of the 36 surveys, 19 were in Asia and 17 in Africa. So far, five countries – Cambodia, China, Myanmar, the Philippines and Viet Nam – have undertaken repeat surveys.[1]

These surveys provide a baseline that can inform assessment of national and global progress towards the milestones (for 2025) and targets (for 2030 and 2035) for reductions in TB incidence set in the WHO End TB Strategy and the UN Sustainable Development Goals *(16, 17)*, and ultimately, assessment of whether these milestones and targets are achieved.

4. Where do surveys remain potentially relevant?

Among the subset of countries that do not yet have national disease notification and VR systems of high quality and coverage, a national TB prevalence survey is not necessarily a viable option for assessment of the burden of TB disease in all of them. Both epidemiological and feasibility criteria need to be considered.

4.1 Epidemiological criteria

If the level of TB disease burden is low (relative to population), the sample size required to obtain a reliable estimate of the number of people with TB disease in the population becomes prohibitively large. This means that national TB prevalence surveys should only be considered in countries in which the estimated level of TB disease burden is above a certain threshold.

For countries that implemented a survey in the period 2007–2023, **Table 1** shows epidemiological criteria[2] that can be used to assess whether a repeat survey should be considered, and the countries that meet these criteria, either during the period 2024–2026 or 2027–2030.

Five countries that implemented a survey between 2007 and 2015 do not meet the epidemiological criteria for implementing further surveys because their burden is low: China, Gambia, Rwanda, Sudan and Thailand.

Table 1. Epidemiological criteria that can be used to assess whether a country that implemented a survey between 2007 and 2023 should consider implementing a repeat survey in the years leading up to 2030, and countries that meet these criteria

Criteria	Explanation of criteria	Countries that meet both criteria[b]
1. Estimated prevalence of bacteriologically confirmed pulmonary TB ≥250 per 100 000 population aged ≥15 years during the previous survey *and*	Sample size small enough (<70 000 individuals) to make surveys feasible in terms of cost and logistics	Meet criteria in period 2024–2026: Bangladesh, Democratic People’s Republic of Korea, Ethiopia, Ghana, Indonesia, Kenya, Lao People’s Democratic Republic, Malawi, Mongolia, Nigeria, Pakistan, the Philippines, Uganda, United Republic of Tanzania, Zambia, Zimbabwe (n=16)
2. About 10 years since the last survey[a]	Time between surveys is sufficient for a repeat survey to measure a statistically significant change	Meet criteria in period 2027–2030: Eswatini, India, Lesotho, Mozambique, Myanmar, Namibia, Nepal, South Africa, Viet Nam (n=9)

[a] An interval of about 10 years between two surveys is recommended to allow assessment of trends.
[b] Cambodia and Timor-Leste are not listed since they implemented surveys in 2023–2024 and 2022–2023, respectively.

[1] Bangladesh in not included because the first survey (in 2008) used methods that were different from those recommended in WHO guidance issued in 2011 *(15)*, with no use of CXR or symptom screening. The survey in 2015 was the first to use methods recommended in this guidance. China implemented surveys in 1990, 2000 and 2010.
[2] The criteria are based on those discussed and agreed at a WHO meeting in 2016 *(18)*.

For countries that have not previously implemented a survey, **Table 2** shows epidemiological criteria[1] that can be used to assess whether a first survey should be considered, and the countries that currently meet these criteria. The 25 countries that meet the criteria coincide with those for which WHO estimates of TB incidence currently rely on a combination of case notification data and expert opinion about case detection gaps (due to underreporting and underdiagnosis).

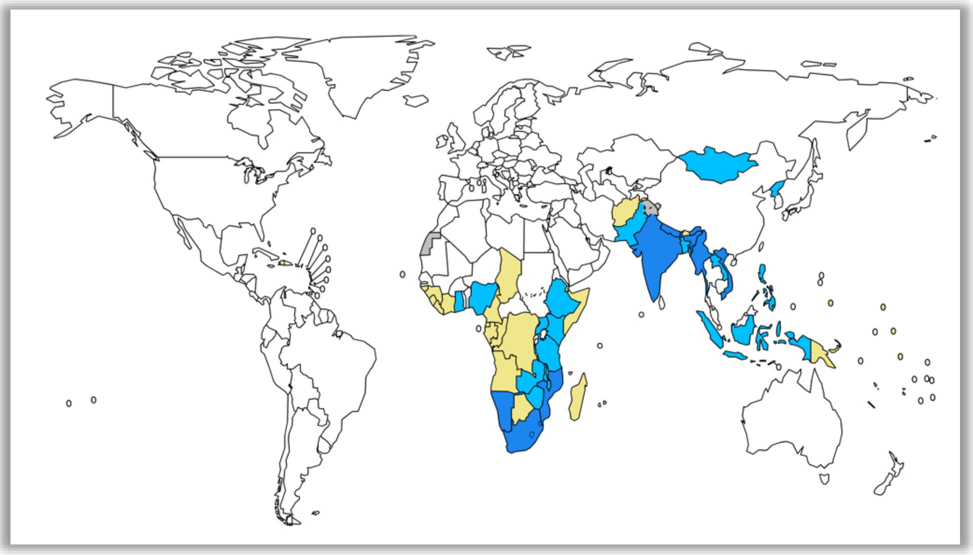
Table 2. Epidemiological criteria that can be used to assess whether a country should consider implementing a national TB prevalence survey, for countries that have not previously implemented a survey

Criteria	Explanation of criteria	Countries that currently meet criteria
1. Estimated TB incidence ≥150 per 100 000 population per year (all forms, all ages)[a] *and*	Sample size small enough (<70 000 individuals) to make survey feasible in terms of cost and logistics	Afghanistan, Angola, Bhutan, Botswana, Cameroon, the Central African Republic, Chad, the Congo, Côte d'Ivoire, the Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Gabon, Guinea, Guinea-Bissau, Haiti, Kiribati, Liberia, Madagascar, Marshall Islands, Micronesia, Papua New Guinea, Sierra Leone, Somalia and Tuvalu (n=25)
2. No national or sample VR system of high coverage and quality that includes coding of causes of deaths according to international standards *and*	No reliable direct measurement of TB disease burden	
3. UHC service coverage index score is <80 (SDG Indicator 3.8.1) *(19)*	This is an indirect indicator of insufficient access to quality health services, as defined in the WHO TB surveillance checklist of standards and benchmarks (second edition) *(20)*	

UHC: universal health coverage.
[a] For survey sample size calculations, prevalence in those aged ≥15 years can be estimated from incidence.

The countries listed in **Table 1** and **Table 2** are depicted in **Fig. 3**.

Fig. 3. Countries that meet epidemiological criteria for considering a repeat or first national TB prevalence survey in the years leading up to 2030



Meet epidemiological criteria for a repeat survey in 2024–2026
Meet epidemiological criteria for a repeat survey in 2027–2030
Meet epidemiological criteria for a first-ever survey
Not applicable

[1] The criteria are based on those discussed and agreed at a WHO meeting in 2016 *(18)*.

4.2 Feasibility criteria

For countries that meet the epidemiological criteria for considering implementation of a national TB prevalence survey, there are also important non-epidemiological requirements that must be satisfied, both before a survey can be embarked upon and throughout its implementation. These were clearly identified in 2011 *(5)* and are summarized in Box 1.[1] Among these factors, one that is fundamental is that the security situation in the country allows for both a nationally representative survey (without exclusion of large parts of the country), and the safety of field teams and survey participants during survey operations.

Box 1. Non-epidemiological requirements that must be satisfied before a national TB prevalence survey can be embarked upon

For countries that meet epidemiological criteria for implementing a national TB prevalence survey, there are various other requirements, both before a survey can be embarked upon and throughout its implementation.

These include:

- strong commitment and leadership from the NTP, the ministry of health and a core group of professionals;
- availability of a suitable institute, organization or agency to lead and manage the survey;
- the national security situation is such that a nationally representative survey is feasible, and the safety of survey field teams and participants can be assured throughout the survey;
- availability of the funding required to implement a survey;
- confidence that a sufficiently high participation rate among the eligible population can be achieved, based on either a previous national TB prevalence survey or a comparable type of survey – community engagement, starting with the preparatory phase of the survey and continuing throughout, is crucial to help ensure high participation;
- availability of adequate laboratory capacity (or confidence that such availability can be established before the survey), for both Xpert® MTB/RIF Ultra (Xpert Ultra) and liquid culture testing;
- capacity to undertake CXR examinations in the field in compliance with the regulations of the national radiation authority (or confidence that such capacity can be established before the survey);
- capacity to adhere to good clinical practice and good data management practices;
- feasibility of reliable and timely procurement of equipment (especially X-ray equipment);
- survey protocols have undergone expert review and clearance (including ethical clearance); and
- availability of external support and technical assistance, if required (this is particularly relevant for countries implementing a national TB prevalence survey for the first time).

5. Concerns and questions about surveys

The rationale for a renewed effort to implement national TB prevalence surveys in the period 2007–2015 was agreed upon at the 2007 meeting of the WHO Global Task Force on TB Impact Measurement and has been set out in various publications *(2, 3, 11, 15, 21)*.

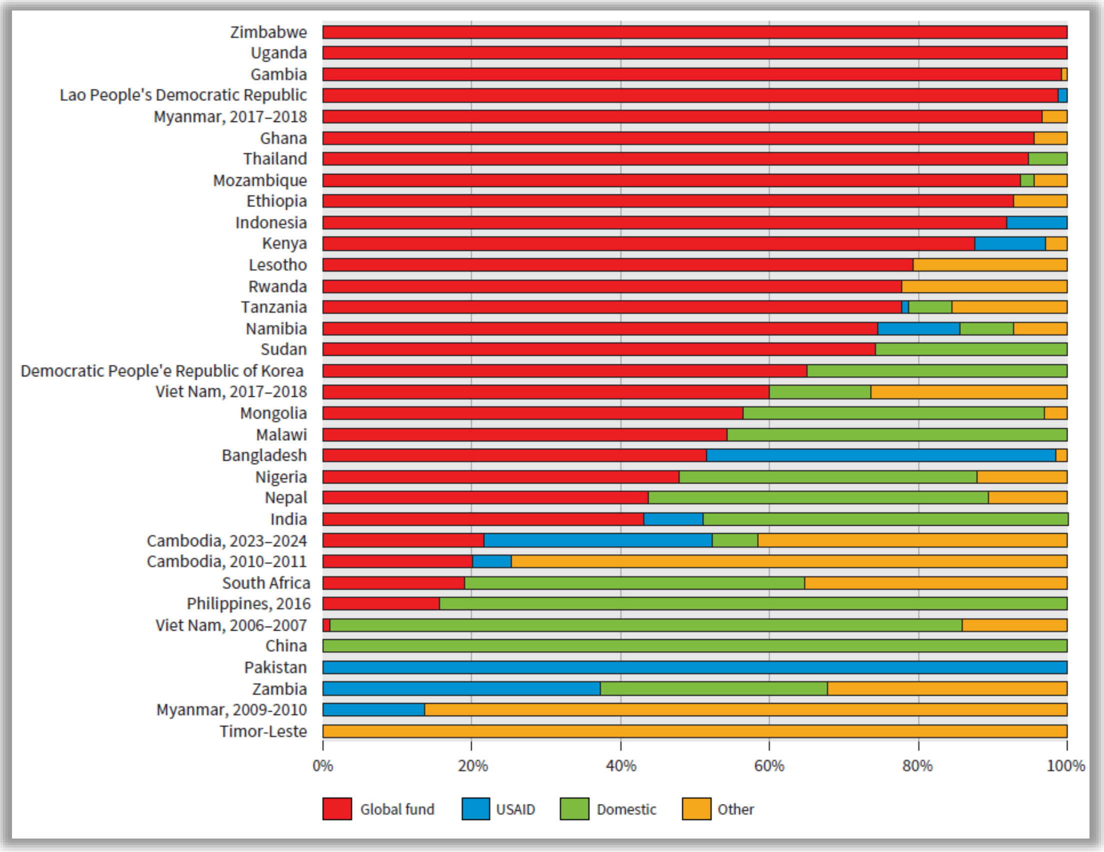
In the two decades before that, a few countries, notably in the WHO Western Pacific Region, had already implemented surveys to assess the absolute level of and trends in TB disease burden: they included Cambodia (2002)*(22)*, China (1990, 2000)*(23)*, the Philippines (1987, 1997, 2007)*(24, 25)* and Viet Nam (2007)*(26)*.

By the mid-late 2000s, a considerable and growing number of countries already considered a national TB prevalence survey to be a high priority, to better understand their level of TB disease burden and the status of progress towards global TB targets. Almost all of these countries included funding for prevalence surveys in applications to the Global Fund, and most of the surveys implemented between 2007 and 2023 were funded predominantly by the Fund (**Fig. 4**). Exceptions that were mostly funded from domestic sources included China (2010), the Philippines (2016), South Africa (2017) and Viet Nam (2007). Exceptions that were mostly funded from other international donor sources included Bangladesh (2015, USAID), Cambodia (2010, Japanese government), Myanmar (2009, 3-diseases

[1] The list has been updated where appropriate; for example, in terms of the type of tests for which laboratory capacity is needed.

fund), Pakistan (2011, USAID), Timor-Leste (2023, Australian government) and Zambia (2014, USAID and other donors). Under the umbrella of the WHO Global Task Force on TB Impact Measurement, substantial efforts were made by WHO and partner agencies to support countries to design and implement these surveys, and to analyse, report and use survey data, based on WHO guidance.

Fig. 4 Sources of funding for national TB prevalence surveys (expressed as a share of the total reported budget[a]), 2007–2024



USAID, United States Agency for International Development.

[a] Budget at the time of the survey. Other refers to financial contributions from partners not listed (e.g. Bill & Melinda Gates Foundation, KNCV Tuberculosis Foundation, Japan International Cooperation Agency (JICA), Population Services International, Three Diseases Fund, United States Centers for Disease Control, World Health Organization, The World Bank), other external Government funds (e.g. Australia, France, Netherlands), or a mixture of contributions that could not be disaggregated. These proportions are an approximation based on survey reports, and personal communications. There were instances where in-kind contributions or survey staff who were seconded from other funded projects were not documented. A budget was not available for the Philippines (2007); budget breakdowns were not available for Eswatini and Mozambique.

Since 2015, national TB prevalence surveys have been part of the WHO Global Task Force on TB Impact Measurement's second strategic area of work, defined as "Priority studies to periodically measure TB disease burden". Since 2015, 13 countries[1] have implemented a survey (including 4 repeat surveys[2]) and several countries are currently considering implementation of a repeat survey.

In recent years, concerns have been raised about whether prevalence surveys should continue to be implemented. These concerns include their cost, that they take too long and that they can distract from or displace core NTP activities. These concerns are accompanied by questions about whether surveys can be implemented "more efficiently", or "at lower cost", or whether there are better alternatives that could be relied upon instead. These are discussed in turn below.

[1] Cambodia*, Democratic People's Republic of Korea, Eswatini, India, Mozambique, Lesotho, Myanmar*, Namibia, Nepal, the Philippines, South Africa, Timor-Leste and Viet Nam* (*repeat surveys).

[2] Cambodia (2010–2011 & 2023–2024), Myanmar (2009–2010 & 2017–2018), Philippines (2007 & 2016) and Viet Nam (2006–2007 & 2017–2018).

5.1 Surveys cost too much

5.1.1 Reported budgets of surveys, 2007–2024

The reported budgets for 35 national TB prevalence surveys conducted between 2007 to 2024 are shown in **Table 3**. For comparability, the table shows not only the reported budget in the year of the survey, but also budgets in a common year of prices (constant 2022 US$).

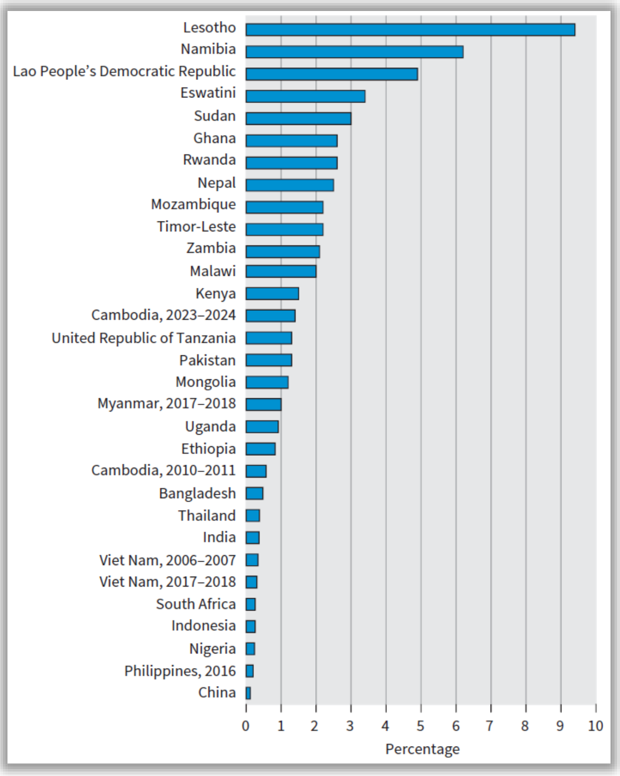
Budgets (in constant 2022 US$) ranged from just over US$ 1 million (in Timor-Leste) to US$ 15.6 million in India; the latter was a particularly large survey (322 480 participants) that was designed to provide subnational as well as national estimates. The overall average (mean) budget was US$ 3.8 million and the median was US$ 2.9 million.

Overall, the average survey budgets in African and Asian countries were similar: US$ 3.5 million and US$ 3.3 million respectively. The average budget (again, in constant US$ values for 2022) per cluster was around US$ 25 000 in Asian countries and US$ 50 000 in African countries, with the approximate cost per cluster ranging from as low as US$ 11 000 in Mongolia (2014–2015) to a high of US$ 82 000 in Zambia (2013–2014).[1] The main cost drivers are shown below.

5.1.2 Survey budgets as a share of overall funding for the TB response at national level

When survey budgets are annualized over a 10-year period (the recommended duration between surveys), the survey budget was equivalent to between <0.1% and 9.4% of the total amount of annual funding available for the national TB response over this period, with a median of 1.3% (**Table 3**, **Fig. 5**). In other words, when the cost of the survey is spread across 10 years, the cost of a survey is equivalent to about 1% of the available funding for TB, in most countries. In general, the larger the country (in terms of population and geographic size), the lower the percentage. In countries with particularly small populations, surveys can account for a large share of total funding available for the TB response (e.g. over 5% in Namibia and close to 10% in Lesotho).

Fig. 5. Annualized survey budget (in constant US$ values for 2022) as a percentage of the total amount of funding available for the TB response at country level in 2022, 31 national TB prevalence surveys implemented between 2007 and 2024
The annualized budget assumes that the expected lifetime of a survey is 10 years and a discount rate of 3%.



[1] In Zambia, costs for external technical assistance were included in the budget for overall field operations; these costs were usually not included in the survey budgets of other countries.

Table 3. **Reported budgets[a] for 35 national TB prevalence surveys implemented between 2007 and 2024**

Country	Year(s) of field operation	Number of survey participants	Number of clusters	Survey budget in main survey year, US$ millions (current values for the survey year)	Survey budget, US$ millions (2022 constant values)[b]	Annualized survey budget, US$ millions (2022 constant values)[c]	Annualized survey budget (AB) per cluster, US$ (2022 constant values)	Available funding (AF) for the TB response, US$ (2022 constant values)[d]	Annualized survey budget (AB) as a percentage of available funding (AF) for the TB response in 2022
Bangladesh	2015–2016	98 710	125	3.6	5.1	0.60	40 958	126 120 335	0.48%
Cambodia, 2010–2011	2010–2011	37 417	62	1.0	1.3	0.16	21 656	27 616 682	0.57%
Cambodia, 2023–2024	2023–2024	34 836	84	3.3	3.3	0.39	39 286	27 616 682	1.4%
China	2010	252 940	176	5.6	7.6	0.90	43 416	762 621 837	0.12%
DPR Korea	2015–2016	60 683	100	1.4	-	-	-	57 058 511	-
Eswatini	2018–2019	24 356	70	3.8	3.5	0.41	49 532	12 114 550	3.4%
Ethiopia	2010–2011	46 697	85	2.8	4.7	0.55	54 941	65 623 061	0.83%
The Gambia	2011–2013	43 100	80	1.9	2.0	0.24	23 750	-	-
Ghana	2013	61 726	98	2.2	1.8	0.21	18 226	7 964 693	2.6%
India	2019-2021	322 480	443	15.1	16.6	1.95	37 582	531 323 222	0.37%
Indonesia	2013–2014	67 944	156	4.6	4.6	0.54	29 703	212 382 342	0.26%
Kenya	2015–2016	63 050	100	5.2	6.2	0.73	62 197	48 645 759	1.5%
Lao PDR	2010–2012	39 212	50	1.3	1.4	0.17	28 566	3 416 834	4.9%
Lesotho	2019	21 719	54	2.8	2.8	0.33	51 509	3 461 496	9.4%
Malawi	2013–2014	31 579	74	2.2	3.4	0.40	46 287	19 647 116	2.0%
Mongolia	2014–2015	50 309	98	1.1	1.2	0.14	12 373	12 233 689	1.2%
Mozambique	2018–2019	32 445	72	5.8	6.6	0.77	91 497	34 890 431	2.2%
Myanmar, 2009–2010	2009–2010	51 367	70	0.90	-	-	-	34 787 328	-
Myanmar, 2017–2018	2017–2018	66 480	138	2.0	2.9	0.34	21 183	34 787 328	1.0%
Namibia	2017–2018	29 495	68	5.5	5.4	0.63	78 997	10 154 478	6.2%
Nepal	2018–2019	54 200	99	4.1	4.4	0.52	44 634	20 449 740	2.5%
Nigeria	2012	44 186	70	3.1	2.5	0.30	36 234	122 354 463	0.24%
Pakistan	2010–2011	105 913	95	4.4	4.6	0.54	48 657	41 405 703	1.3%
Philippines, 2016	2016	46 689	108	2.4	2.5	0.29	22 702	142 297 938	0.20%

Country	Year(s) of field operation	Number of survey participants	Number of clusters	Survey budget in main survey year, US$ millions (current values for the survey year)	Survey budget, US$ millions (2022 constant values)[b]	Annualized survey budget, US$ millions (2022 constant values)[c]	Annualized survey budget (AB) per cluster, US$ (2022 constant values)	Available funding (AF) for the TB response, US$ (2022 constant values)[d]	Annualized survey budget (AB) as a percentage of available funding (AF) for the TB response in 2022
Rwanda	2012	43 128	73	2.4	2.3	0.27	31 147	10 240 315	2.6%
South Africa	2017–2019	35 191	110	5.1	5.1	0.60	46 373	229 832 329	0.26%
Sudan	2013–2014	83 202	114	1.9	1.5	0.18	13 404	6 069 670	3.0%
Thailand [e]	2012–2013	62 536	100	1.9	2.0	0.23	19 731	60 137 223	0.38%
Timor-Leste	2022-2023	15 267	50	1.1	1.1	0.13	22 000	57 47 350	2.2%
Uganda	2014–2015	41 454	70	2.8	2.7	0.32	38 651	34 643 793	0.92%
United Republic of Tanzania	2011–2012	50 447	62	3.4	4.2	0.49	67 091	36 876 839	1.3%
Viet Nam, 2006–2007	2006–2007	94 179	70	1.0	2.4	0.28	34 225	83 518 842	0.34%
Viet Nam, 2017–2018	2017–2018	61 763	82	2.0	2.2	0.26	26 950	83 518 842	0.31%
Zambia	2013–2014	46 099	66	5.4	4.2	0.50	64 143	23 861 420	2.1%
Zimbabwe	2014	44 951	75	3.5	-	-	-	20 672 356	-

[a] Survey budgets were obtained from *(21)* and personal communication with survey teams from Cambodia, 2023–2024; Eswatini; India; Lesotho; Myanmar, 2017–2018; Mozambique; Nepal; South Africa; Timor-Leste and Viet Nam, 2017–2018. A budget was not available for the Philippines, 2007.

[b] The survey budget from the main year of the survey was inflated to the value of US dollars (2022) by using published Gross Domestic Product deflator values and conversion from local currency to US$ using published official exchange rates for 2022 (Source: The World Bank database https://data.worldbank.org/). Values could not be calculated for surveys conducted in Democratic People's Republic of Korea, Myanmar, 2009–2010 or Zimbabwe. For Malawi and Myanmar, exchange rates for 2020 were used, and for the United Republic of Tanzania, exchange rates for 2021 were used, because values for 2022 were not available.

[c] The annualized survey budget was obtained by dividing the survey budget (in US$, constant values for 2022) by the annualization factor (8.53) that applies for a discount rate of 3% and an assumed lifetime of 10 years (i.e. assuming that surveys are done approximately once every 10 years).

[d] Available funding obtained from the Global Tuberculosis Report, 2023 *(1)*. Data were not available for The Gambia.

[e] Thailand's survey originally had a sample size of 90 000 but this was reduced to 74 700, which excluded the Bangkok area. There were 62 536 participants from the non-Bangkok area.

Of note, the reported budget for a national TB prevalence survey may under or over-state the true cost of a survey. The full economic cost of a survey is defined as the market value of all resources used in the survey. When the value of the time of staff needed to manage a survey and implement field operations is not included in a survey budget because those staff are already employed by the NTP or Ministry of Health, or the survey makes use of volunteers who are not paid, or the survey budget does not include technical assistance provided by international agencies or consultants (that might be funded from separate funding sources and budgets), the survey budget will be less than the true cost of the survey. It is useful to define and list all in-kind contributions, in particular to help to identify domestic contributions to the survey that might otherwise be missed.

On the other hand, when the budget includes the full purchase price of equipment (e.g. laboratory equipment, X-ray machines), vehicles and other items with a useful life that extends beyond the completion of the survey, the survey budget will be higher than the real cost of the survey. For example, if a survey takes a year to complete and the useful life of X-ray machines, vehicles and laboratory equipment is 8 years, the real cost of these items for the survey itself will be only a fraction more than one eighth of their purchase price (i.e. the total cost is divided by a factor that allows for the need to pay the full cost of these items upfront, rather than spreading the payment over time, and that allows for their full useful life). This is the reason for showing annualized budget values in **Table 3** and **Fig. 5**.

5.1.3 Survey budgets in the context of current levels of global funding for the TB response and global funding targets set at the 2023 UN high-level meeting on TB

The total budgets of the 35 surveys implemented between 2007 and 2024 (in constant 2022 US$)[1] amounted to US$ 128 million, with an annualized value of US$ 15 million. This is equivalent to about 1.5% of the international donor funding provided for TB each year (around US$ 1 billion), and about 0.3% of the total funding (around US$ 6 billion, from domestic and international sources) for the TB response in all low and middle-income countries.

The political declaration at the 2023 UN high-level meeting on TB included new targets for the global funding to be mobilized for the TB response: US$ 27 billion annually by 2027 for universal access to TB prevention, diagnosis, treatment and care, rising to US$ 35 billion annually by 2030; and US$ 5 billion per year for TB research by 2027.

As an illustrative example, if 10 national TB prevalence surveys were implemented between 2026 and 2030 at a cost of US$ 5 million each, the total cost of US$ 50 million would equate to an annualized cost (spread over 10 years) of about US$ 5.9 million. This would be equivalent to about 0.6% of current international donor funding for TB per year, 0.1% of the current level of total funding for TB in low and middle-income countries each year, and 0.02% of the funding target of US$ 30 billion per year that has been set for 2030.

5.2 Surveys take too long

Surveys are time consuming to prepare and implement, and once field operations and diagnostic testing are completed the analysis of data, preparation of a report and dissemination of findings can also take a considerable amount of time**.** **Fig. 6** provides a summary of the time taken to prepare for a survey, to conduct field operations, and the time between the completion of field operations and the finalization of survey results for official dissemination (or a publication), for surveys implemented since 2007. Field operations usually take around 10–12 months, and a further 2 months or so is needed to complete diagnostic testing.

The time between a decision to implement a survey and the start of field operations has varied widely (ranging from 1 year to more than 4 years). The most common reasons for delays in starting a survey include the time taken to mobilize the funding required, and the time required to procure equipment (in particular, X-ray machines). Strong leadership, full time survey staff, and previous experience of conducting national level surveys help to expedite survey preparations. Following the completion of field operations, reasons for delays in finalizing results include challenges with data management (particularly

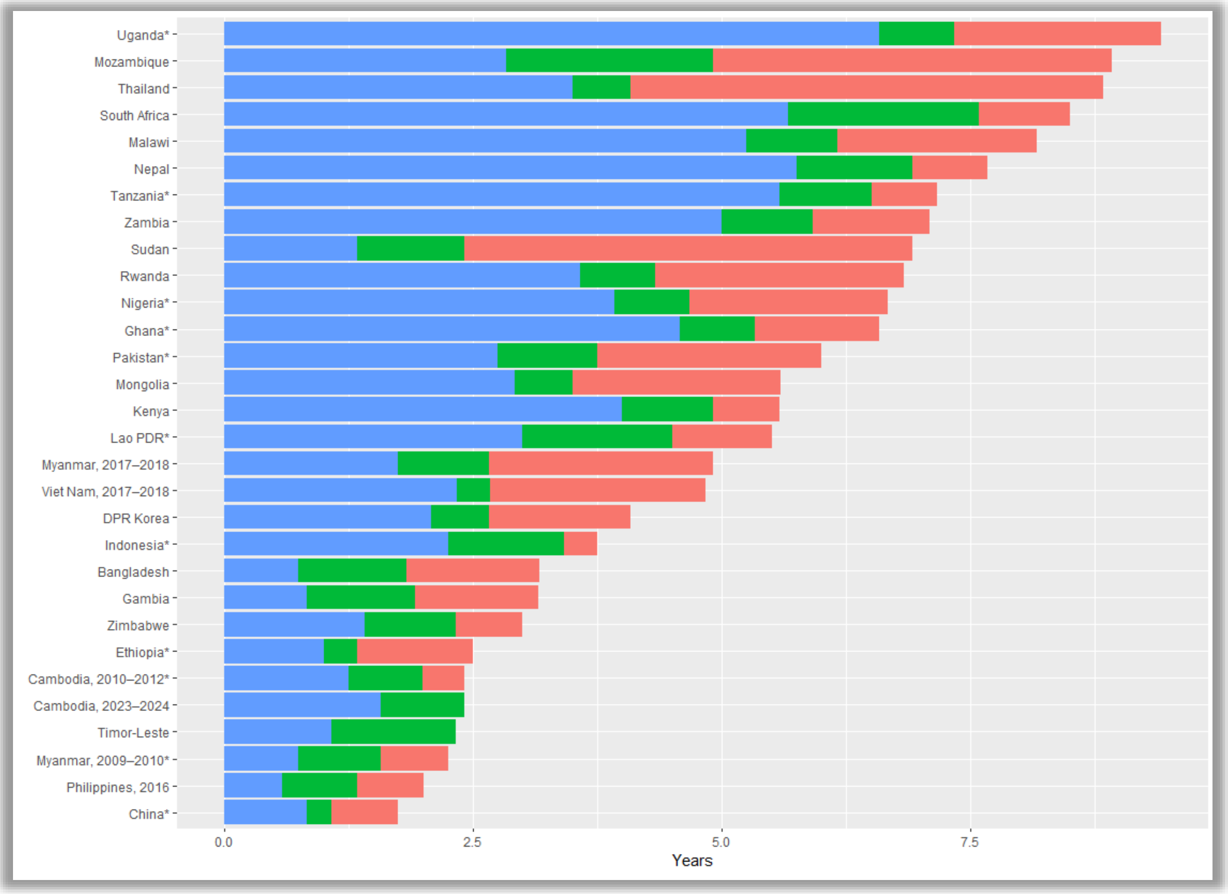
[1] With the exception of the Democratic People's Republic of Korea, Myanmar (2009) and Zimbabwe, for which current values in the year of the survey were used, as explained in the footnotes to **Table 3**.

in earlier surveys that relied extensively on paper-based data collection) and, particularly for surveys implemented since 2015, the interpretation of discordant Xpert and culture results.[1] The lack of human resources has delayed writing of a survey report and related publications in several countries.

In the most recent survey to be completed – the 2023/2024 survey in Cambodia – field operations lasted 11 months (July 2023–May 2024). However, the survey was beset by delays, initially due to the COVID-19 pandemic[2] and subsequently a general election and issues related to funding disbursement (the latter in part due to the end of funding cycles, a problem that would not have occurred if the survey had not been delayed by the pandemic). Results are scheduled for finalization and dissemination in September 2024.

National surveys implemented since 2007 have mostly been a country's first-ever survey. Repeat surveys may be easier to implement, given the expertise and experience that was gained during the first survey as well as the extensive experience and lessons learned from many countries that can now be drawn upon. There may also be better availability of required equipment, including X-ray machines. Nonetheless, the time between a decision to implement a survey and the availability of final results could take 2–3 years.

Fig. 6. Approximate time taken (in years) for 30 countries to complete a national TB prevalence: from survey preparation and field operations to official dissemination or first publication[a]



Preparation time (e.g. first official meeting, ethics review submission)
Duration of field operations
Duration to official dissemination (*) or first publication (report or peer-reviewed paper)

[a] Surveys in Cambodia and Timor-Leste have only just been completed and a report is pending.

[1] This challenge should not occur in future surveys, following updates to the diagnostic algorithms and associated case definitions now recommended by WHO *(11, 27)*.
[2] The survey was initially planned to start in September 2022.

5.3 Surveys distract NTPs from their core, priority work

If responsibility for leading, managing and implementing a survey is assigned to NTP staff, this could seriously compromise essential programmatic activities. Leading and managing a survey is time consuming, and survey field operations typically require 3–6 field teams of 10–15 people, for a period of several months.

The role of NTP staff in surveys implemented from 2007–2024 is summarized in **Table 4**. In general:

- More surveys in Asia were led and managed by NTPs/Ministries of Health (MOH), whereas more surveys in Africa were led (or co-led) by a separate partner other than the NTPs/MOH.
- Surveys were generally a collaboration of institutions and groups and surveys in only a few countries were managed and implemented by the NTP/MOH alone (e.g. China, Democratic People's Republic of Korea, Lao People's Democratic Republic, Malawi, Viet Nam).
- In general, NTP/MOH-led surveys hired staff to conduct field operations (and thus did not conduct such operations using existing staff); NTP staff were, however, part of the ongoing monitoring process.
- The in-country human resource capacity and organizational structure of the NTP/MOH influenced whether or not a survey was directly managed by the NTP/MOH.
- Some surveys were managed by national research institutions of the MOH e.g. Ethiopia, Indonesia, Zambia, Zimbabwe.
- Most NTP managers were the PI or co-PI of the survey.
- Surveys that included the active involvement of NTP staff helped to ensure ownership of the survey; often, they also brought more attention to and a greater appreciation of TB clinical and programmatic management at lower administrative levels.

Table 4. Roles and responsibilities of NTP staff and other entities, national TB prevalence surveys implemented 2007–2024

Countries (in Africa and Asia)	Separate entity from NTP contracted to lead, manage and implement survey	Implementing partners	MOH/NTP staff PI/co-PIs	Field teams consisted entirely of NTP/MOH staff	Field teams included NTP staff (or were recruited by the NTP)
Eswatini	Yes	**NTP**/UCSF	Yes	No	Yes
Ethiopia	Yes	EPHI, EHNRI	Yes	No	Yes
The Gambia	Yes	MRC (UK)	No	No	?
Ghana	No	**NTP**	Yes	No	Yes
Kenya	No	**NTP**	Yes	No	Yes
Lesotho	Yes	URC	Yes	No	Yes
Malawi	Yes	**NTP**/UoM	Yes	Yes	Yes
Mozambique	Yes	**NTP**/UCSF	Yes	No	Yes
Namibia	No	**NTP**	Yes	No	Yes
Nigeria	No	**NTP**	Yes	No	?
Rwanda	Yes	RBC	Yes	No	Yes
South Africa	Yes	HSRC/SAMRC/NICD	Yes	No	No
Sudan	Yes	**NTP**/PHI	No	No	No
Uganda	Yes	MU	Yes	No	No
UR Tanzania	No	**NTP**	Yes	?	?
Zambia	No	**NTP**	Yes	No	Yes
Zimbabwe	Yes	**NTP**/BRTI	Yes	No	?
Bangladesh	Yes	IEDCR	No	No	?
Cambodia, 2010-2011	No	**NTP**	Yes	Yes	Yes
Cambodia, 2023-2024	Yes	**NTP**/RIT-JATA/HSD/CATA/IPC	Yes	No	Yes
China	No	**NTP**	Yes	Yes	Yes
DPR Korea	No	**NTP**	Yes	Yes	Yes
India	Yes	**NTP**/ NIRT/ ICMR/ WHO / STDC	Yes	No	Yes
Indonesia	Yes	NIHRD	No	No	No
Lao PDR	No	**NTP**	Yes	Yes	Yes
Mongolia	No	**NTP**	Yes	Yes	Yes
Myanmar, 2009-2010	No	**NTP**	Yes	No	Yes
Myanmar, 2017-2018	No	**NTP**	Yes	No	Yes
Nepal	Yes	**NTP**/ GENETUP/ JANTRA/ INTREDPID / IOM / WHO	Yes	No	No
Pakistan	No	**NTP**	Yes	Yes	Yes
Philippines, 2007	Yes	**NTP**/TDF	Yes	No	?
Philippines, 2016	Yes	**NTP**/FACE/PCHRD	No	No	No
Thailand	No	**NTP**	Yes	Yes	Yes
Timor-Leste	Yes	**NTP**/MENZIES	Yes	No	No
Viet Nam, 2006-2007	No	**NTP**	Yes	Yes	Yes
Viet Nam, 2017-2018	No	**NTP**	Yes	Yes	Yes

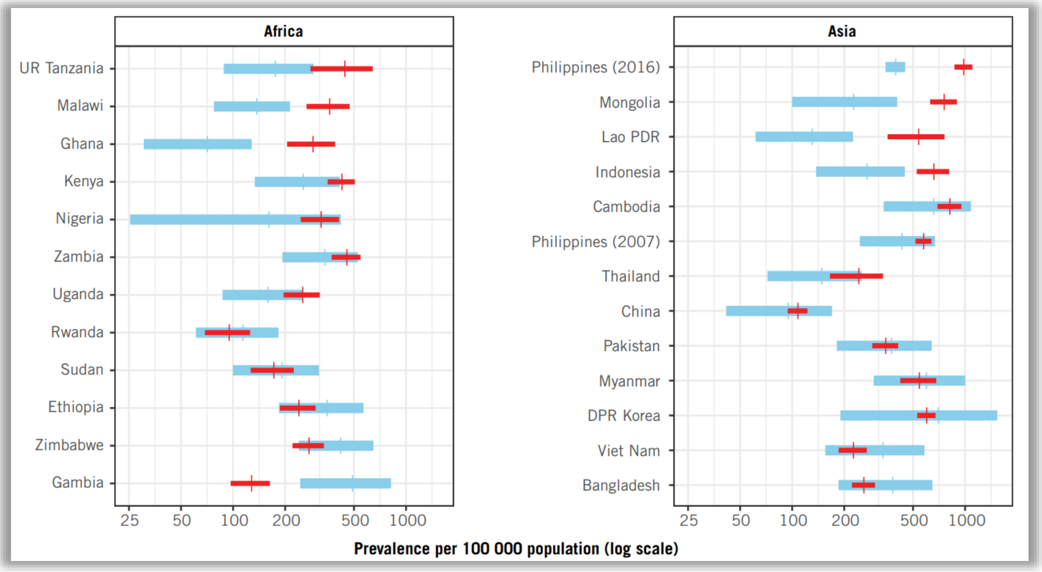
BRTI, Biomedical Research and Training Institute; CATA, Cambodia Anti-Tuberculosis Association; EHNRI, Ethiopian Health and Nutrition Research Institute; EPHI, Ethiopia Public Health Institute; FACE, Foundation for the Advancement of Clinical Epidemiology; GENETUP, German Nepal Tuberculosis Project; HSD, Health and Social Development; HSRC, Human Sciences Research Council; ICMR, Indian Council of Medical Research; IEDCR, Institute of Epidemiology, Disease Control and Research; IOM, International Organization for Migration; IPC, Institute Pasteur du Cambodge; JANTRA, Japan-Nepal Health and Tuberculosis Research Association; MENZIES, Menzies school of health research; MRC, MU, Makerere University; Medical Research Council; NTP, National TB Programme; NICD, National Institute for Communicable Diseases; NIHRD, National Institute of Health Research and Development; NIRT, National Institute for Research in Tuberculosis; PCHRD, Philippine Council for Health Research and Development; PHI, Public Health Institute; RBC, Rwanda Biomedical Center; RIT/JATA, Research Institute of TB/Japan Anti-Tuberculosis Association; SAMRC, South African Medical Research Council; STDC, State TB Demonstration & Training Centre; TDF, Tropical Disease Foundation; UCSF, University of California San Francisco; UoM, University of Malawi; URC, University Research Company; WHO, World Health Organization.

5.4 Surveys provide only a point estimate of disease burden with considerable uncertainty, not much different to non-survey-based estimates

The main rationale for a national TB prevalence survey is to provide a direct measurement of the burden of TB disease in the population, when surveillance data cannot be relied upon for this purpose (**section 2**). Nonetheless, there may be concern that estimates of prevalence derived from surveys are still uncertain and that they may not differ in any meaningful way from estimates that could be produced without a survey.

Estimates of the national prevalence of TB disease (for all forms of TB, and all ages) based on surveys implemented from 2007–2016 (n=25) compared with pre-survey estimates published by WHO are shown in **Fig. 7**.[1] Estimates based on surveys were always more precise than pre-survey estimates and the 95% uncertainty interval of the survey-based estimate often (in 19 out of 25 instances; 10/12 in Africa, 9/13 in Asia) did not overlap with the pre-survey best estimate. Of the other 6 countries, best estimates from the surveys in Pakistan, Myanmar, Democratic Republic of Korea were very consistent with pre-survey best estimates, but with much narrower uncertainty intervals; those for Rwanda, Sudan were lower and the best estimate for China was higher. Overall, 16 and 10 countries under-estimated or over-estimated pre-survey estimates, respectively.

Fig. 7 Comparison of prevalence estimates (all ages, all forms of TB) (red) from 25 surveys compared with pre-survey estimates (blue) published by WHO, for national TB prevalence surveys implemented 2007–2016
Countries are listed in decreasing order according to the before−after difference.



DPR Korea, Democratic People's Republic of Korea; Lao PDR, Lao People's Democratic Republic, UR Tanzania, United Republic of Tanzania.

In addition to providing more robust, accurate and precise estimates of the level of TB disease burden in the population (as illustrated in **Fig. 7**), survey data also provide other information and can be used for purposes beyond estimation of disease burden in a specific year. The main examples are:

- **Trends in TB disease burden and evaluation of intervention impact**. Repeat surveys can be used to assess trends in TB disease burden and to evaluate the impact of interventions implemented since the last survey e.g. Cambodia, China, Myanmar, Philippines and Viet Nam.
- **The distribution of TB disease burden by age and sex**. Surveys provide reliable evidence about how the burden of TB disease is distributed by age and sex. Although men are well-known to account for a larger share of TB case notifications compared with women, this pattern could

[1] Estimates are not shown for later surveys, since WHO stopped publishing estimates of TB prevalence in 2016. **Fig. 7** is reproduced from a WHO publication that provides comprehensive documentation about national TB prevalence surveys implemented between 2007 and 2016 *(4)*.

reflect differences in care-seeking behaviour or access to care as well as the underlying disease burden. Prevalence surveys have shown an even higher relative burden in men than is evident in in notification data, providing direct evidence of a higher underlying burden of TB in men than women.

- **How case detection gaps vary by age and sex**. Surveys have often shown larger gaps among men than women (in terms of the prevalence:notification ratio), and larger gaps in older age groups. Such evidence can potentially inform the development and implementation of policies or interventions to narrow these gaps, and address inequities in access to care.
- **Health care seeking behaviour**. Surveys can provide information about health care seeking behaviour among people with TB disease who are detected by the survey, and in turn what improvements to health services may be required to ensure more prompt TB diagnosis and treatment, in general.
- **Underreporting of people diagnosed with TB**. If data for people identified to be on TB treatment at the time of the survey are compared with official notification data, surveys can provide information about the level of underreporting of people diagnosed with TB to the national surveillance system. This can be used to inform the design and implementation of corrective actions, if required. As an example, the national TB prevalence survey in Indonesia clearly identified issues with underreporting; this led to a decision to implement a national TB inventory study (completed in 2016) and, subsequently, corrective actions to address underreporting.
- **Symptomatic status of people with TB disease in the community**. Since all survey participants are initially screened using an interview about symptoms as well as chest X-rays, they provide information about the symptomatic status of people with TB who were not diagnosed prior to the survey. Prevalence survey data have been the key source of data recently used to highlight and discuss the implications of "subclinical TB" (see also **Background document 1**). They have also shed light on the substantial proportion of people who are a prevalent TB case who report symptoms, but have not sought care for those symptoms, illustrating that there is scope to reduce diagnostic delays (e.g. through better awareness of symptoms in the general population).
- **Evidence about care seeking and access to care according to HIV status.** Prevalence surveys have found a lower prevalence of HIV among people detected as a TB case in the survey, compared with TB case notification data. This suggests better case detection among people living with HIV, possibly linked to large investments that have been made in HIV care programmes. It may also reflect earlier care seeking, for example because of earlier onset of symptoms.
- **Advocacy and resource mobilization**. Survey findings can be used to advocate for action needed to improve TB prevention, diagnosis and treatment and associated funding needs.

5.5 Can surveys be implemented more efficiently, at lower cost?

Given concerns about the high cost of surveys (**section 5.1**), a question that can follow is whether surveys could be implemented more efficiently, at lower cost.

When the budget line items of surveys are analysed, there are usually three major categories of cost (**Fig. 8**): field operations; staff; equipment and supplies. Each of these three categories generally accounts for about 30% of the total survey budget.

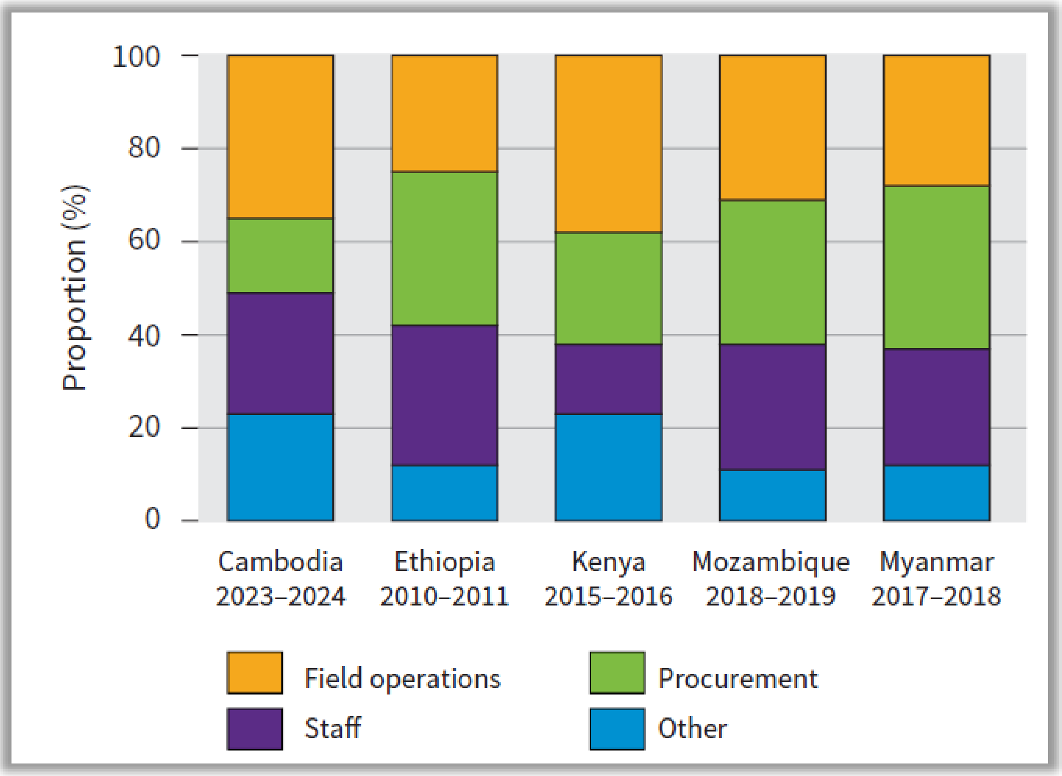
The budget required for **field operations** (excluding staff costs) is closely related to the number of survey clusters, the length of field operations and the nature of the terrain.

- The financial outlay required for a survey (although not its true economic cost) could be reduced by using vehicles that are already available.
- The number of survey clusters is based on the required sample size and associated number of clusters (with a recommended cluster size of 400–800 people).[1] Reducing the number of clusters simply to save costs would compromise the value of a survey.

[1] The required sample size is determined by the pre-survey "guess" of the point estimate, the desired precision of the survey estimate and the anticipated design effect. These are all discussed in the Sampling design chapter of WHO guidance on national TB prevalence surveys.

- The larger the number of clusters that are in relatively inaccessible areas with difficult terrain, the higher the required budget for items such as vehicles or other forms of transportation.
- One reason why survey costs were typically higher in African compared with Asian countries was the geographically large sizes of countries relative to population, on average, and the comparative geographical inaccessibility of large areas.

Fig. 8. Distribution of survey budgets by major cost category – illustrative examples[a]



[a] "Other" includes training, dissemination, workshops, meetings and administration. Field operations may include field staff salaries.

The budget required for **staff costs** includes the salaries and fees of the people responsible for overall coordination of the survey and those responsible for the implementation of field operations (the field teams).

- The level of salaries and per diems varies among countries and is usually closely related to the overall average income level of the country.
- Typically, a survey will require at least three field teams, but more may be required to complete field operations within 6–12 months.
- Whether or not a specific budget is needed for such staff varies among countries. Again, however, this affects the financial outlay required specifically for a survey, but not its true economic cost (assuming staff do not have spare capacity).
- In several countries, surveys relied on NTP staff (Table 4) and/or local staff at the community level who were employed by the Ministry of Health (or equivalent), with no staffing budget required for the survey per se. In others, a specific budget was required for an outsourced central survey team (for example, based at a university or research institute) and associated field teams. The latter approach was often used in African countries, and is one reason why survey budgets were typically higher than in Asian countries.

The budget required for **equipment and supplies** needs to cover any items that need to be procured, such as chest X-ray machines, laboratory equipment, IT equipment and laboratory consumables.

- The transition from analogue to digital chest X-ray systems has vastly improved the portability, delivery, reading and storage of the chest X-ray equipment needed for mass population screening. However, such systems do require a significant outlay. The cost for 1 unit of X-ray equipment is approximately US$ 95 000 (2024 prices) if direct digital radiography is used.

- For the ideal survey duration of 6–8 months with 3–5 survey teams, the number of X-ray machines corresponds to the number of survey teams. Some countries may decide to purchase an additional back-up machine, to avoid delays to field operations if one unit breaks down. For geographically challenging regions, an extra and more portable X-ray machine might also be required.
- The financial outlay required for a survey (although not its true economic cost) could be reduced by using digital X-ray equipment that is already available.

Potential ways to minimize financial outlays and optimize the use of resources include:
- Using equipment and transportation that are already available (as also commented above).
- For any items that need to be purchased, ensuring that they will be useful for other purposes once the survey has been completed. For example, any X-ray equipment that needs to be purchased should be compatible with what is needed within health facilities or for future active case finding activities.
- Using in-country technical expertise from other government institutions, academia, national laboratories and technical partners wherever possible. There may be also opportunities to draw on expertise available in neighbouring or nearby countries that have already conducted a survey.

6. What are the alternatives to national TB prevalence surveys to produce estimates of TB incidence?

As shown in **Fig. 1**, national TB prevalence surveys are currently the main source of data used to produce estimates of TB incidence for 29 countries, which collectively account for about two thirds of the annual global number of incident cases.

There are currently three alternative methods, as also shown in **Fig. 1** (and described in more detail in **Background document 1**):
1. **National TB inventory studies**. These measure the level of underreporting of people diagnosed with TB in official TB case notification data. If certain assumptions are met, they can also be used to assess the level of underdiagnosis using capture-recapture methods. The criteria that need to be met to consider the implementation of an inventory study, and the assumptions that need to be met for capture-recapture methods to be used, are listed in **Box 2**. These studies are currently used for 10 countries that collectively account for about 17% of the annual global number of incident cases; China and Indonesia are by far the two most significant in terms of this share (combined, 16.5% of global TB incidence). Other countries that are considering implementation of a national TB inventory study are Mongolia and the Philippines.[1]
2. **Case notification data with a standard adjustment**. The standard adjustment is based on a best estimate that notifications of people newly diagnosed with TB in any given year are equivalent to 85% (with a lower bound of 75% and an upper bound of 100%) of the actual number of incident cases. This method is used for 137 countries (mostly high-income and low TB incidence countries with strong surveillance and health care systems) that collectively account for about 6% of the annual global number of incident cases.
3. **Case notification data combined with expert opinion about case detection gaps (in selected years)**. This is used for 39 countries with 11% of the annual global number of incident TB cases, most of which are in the African Region. Since 2007, a concerted effort has been made to shift away from this method, which is the least preferred.

[1] See also **Table 6** in the next section.

Box 2. National TB inventory studies: criteria that need to be met to consider implementation, and assumptions that need to be met to use capture-recapture methods to estimate the level of underdiagnosis

Estimating incidence using capture-recapture methods depends on: (i) data from an inventory study, and (ii) a series of conditions for the data in that inventory study.

For an inventory study to be considered for implementation, several criteria need to be met:

- The NTP has a digital case-based system to record new episodes of TB;
- A large proportion of cases are diagnosed and treated by at least one health care provider that is a separate entity from the NTP (and two providers that are separate entities, if the objective is to estimate TB incidence using capture-recapture methods). These providers should have a digital case-based system for recording information about people newly diagnosed with TB. As an example, in Indonesia, private non-NTP providers diagnosed 31% of people newly diagnosed with TB in 2023;
- Health-care providers outside the existing NTP network can be mapped and convinced to participate in the inventory study;
- A unique personal identifier is required to allow reliable identification of cases that appear in more than one list. Combinations of non-unique identifiers (e.g., names, dates of birth) may also be used, if they are deemed accurate and reliable and either allow individuals to be uniquely identified or enable probabilistic matching;
- A standard case definition is used across all health-care providers; and
- There is in-country expertise in sampling design, data management and data analysis, including the implementation of record-linkage through probabilistic matching.

For capture-recapture analysis to be justified and feasible, six main assumptions need to be met *(28)*. These are:

1. if S represents the number of case lists or data sources available, then at least three data sources are available ($S \geq 3$) and their dependencies can be accounted for in the model design;
2. every case has a chance of inclusion (whether they are actually included or not) in at least one of the lists described in point 1;
3. the proportion of mismatches and matching failures in record-linkage is low, which typically requires a large sampling fraction;
4. there is a closed population during the study period (typically 3–6 months);
5. there is homogeneity of within-source observation probabilities across subpopulation groups, such as those defined by socioeconomic and demographic characteristics; and
6. the case definitions used across data sources are consistent.

The most recent example of a national TB inventory study is a repeat study in Indonesia in 2023–2024.

A key consideration in interpreting incidence estimates arising from capture-recapture analysis relates to their estimated uncertainty. Some of the conditions listed above cannot be directly verified (especially condition 2); their implications for the uncertainty of incidence estimates may be substantial but are difficult to quantify. Therefore, uncertainty estimates based on results from capture-recapture analysis should *not* be compared directly with uncertainty estimates using other methods, as any such comparison can give a misleading impression about the relative precision of these approaches (similar caveats apply, for example, when comparing statistical estimates with those obtained from dynamical modelling). Instead, estimates based on capture-recapture analysis should be presented with a careful explanation of the assumptions above, together with the "unmeasurable uncertainty" described here.

New options for consideration are discussed in **Background document 1**. In terms of alternatives to national TB prevalence surveys, two are of relevance. These are:

- Use of data from mass active TB case finding (ACF) campaigns in the general population, to estimate prevalence and in turn inform estimates of incidence, as a replacement for a national TB prevalence survey;
- Use of case notification data in combination with an upward adjustment based on the UHC Service Coverage Index (an SDG indicator being used to assess overall access to essential health services, and for which WHO is producing estimates for the period since 2000). In **background document 1**, this is discussed primarily as an option that could replace a) the use of case notification combined with expert opinion about case detection gaps in selected years and b) the use of case notification data combined with a standard adjustment.

Characteristics of national TB prevalence surveys and ACF campaigns that are relevant to consideration of whether ACF data could offer a viable alternative are described in **Table 5**.

Table 5. National TB prevalence surveys and ACF campaigns: comparison of key characteristics

Characteristic	National TB prevalence surveys	ACF campaigns	Comments
Population screened and study design	Adults aged ≥15 years meeting residency criteria, in randomly selected survey clusters (to ensure data are nationally representative)	Usually target subpopulations at relatively high risk of having TB and/or geographical areas with relatively high TB disease burden	If ACF targets populations at high risk of TB, or areas with an elevated level of TB disease burden, an adjustment would be required to estimate TB prevalence in the general population. Uncertainty in this adjustment introduces additional uncertainty to the estimate of prevalence.
Number of people screened	Sample size varies, but typically around 30 000–70 000, accounting for clustering and the desired precision of the prevalence estimate (see Table 3)	Variable: most typically, thousands; but there are examples of more than 1 million	Recent mass ACF campaign in Uganda (CAST-TB) screened 1.3 million people in its first round (March 2022) and 5.1 million in its second round (September 2022), with the latter equivalent to over 10% of the population (47 million). Mass population screening has been done in the Russian Federation for decades.
Screening algorithm	Interview about symptoms, and chest X-ray	Typically relies on symptom screening, although some recent ACF initiatives are also involving X-ray and ACF in Russian Federation has included X-ray for decades	Prevalence surveys show that relying on symptom screening will miss a large proportion (typically 30 – 70%) of people with bacteriologically positive TB. If screening relies on symptom screening, an upward adjustment would be required to estimate the overall prevalence of bacteriologically positive pulmonary TB in the screened population. This adjustment introduces additional uncertainty to the estimate of prevalence.
Diagnostic algorithm	Two Xpert Ultra tests (to maximize sensitivity) followed by confirmatory testing using liquid culture (MGIT) for all those with a positive rapid test result (to maximize specificity)	Recently, typically relies on single tests with rapid molecular diagnostics	The diagnostic algorithm described for prevalence surveys is the one recommended in the latest (2024) WHO guidance on national TB prevalence surveys. It was defined following extensive discussions, consultations and data analysis *(11)*. Such a high sensitivity, high-specificity algorithm is typically not feasible in ACF; when estimating prevalence, adjustments would be needed, introducing additional uncertainty into prevalence estimates.
Cost	Median of around US$ 3 million; usually in range US$ 1–5 million; more if larger sample size for subnational estimates	Limited data on ACF costs; major cost drivers are likely to be diagnostic testing, X-ray screening (if applied) and staff time required for screening	A large ACF campaign that covers the general population and that uses both chest-Xay for screening and rapid tests for diagnosis will likely cost more than a national TB prevalence survey. It would be more like a national TB prevalence survey (which effectively does ACF in the general population, but at a small scale determined by sample size requirements) at a very large scale.
Standardization of procedures	Survey methods are standardized and need to be adhered to in practice, with strong oversight, training and supervision	ACF can be based on standardized procedures; the extent to which training, oversight and supervision are provided may vary	Prevalence surveys are based on clearly defined standard operating procedures (SOPs), which are set out in the survey protocol and associated documentation, and which should be closely supervised and monitored throughout. If procedures vary in ACF campaigns, this makes them less useful for burden estimation. In future, systematic guidance on making ACF useful for burden estimation may be helpful in addressing these challenges.
Data collection and data management	Specific database used for survey data collection, with a data management plan/protocol involving systematic data quality checks and regular data cleaning throughout the survey	ACF can also use a specific database although no systematic data management plan is currently available	In the absence of a systematic framework, overall data quality in ACF campaigns may vary depending on the context, potentially posing challenges in using these data for burden estimation. As above, incorporating new frameworks for database setup and management could be a useful component in future guidance on making ACF useful for burden estimation
Frequency	Every 10 years (approximately)	Variable, but could be annually or even more frequently	If ACF is repeated, it offers the clear benefit of providing data much more frequently than a prevalence survey. Such data could be used to inform trends; however, the trend might be different in targeted populations, compared with the general population.

7. Which countries could be top global priorities to implement a repeat survey in the years up to 2030?

For assessment of the extent to which TB incidence has changed between the baseline year of the End TB Strategy (2015) and the milestone and target years of 2025 and 2030, repeat national TB prevalence surveys are an option for the countries that implemented a first or repeat survey in or within reasonable proximity of 2015. However, whether they are a suitable option depends on whether a country meets the epidemiological and feasibility criteria summarized in **Table 1** and **Box 1**, as well as other considerations, such as whether there is an equivalent or better option that could be implemented more quickly, more easily and at lower cost.

Table 6 characterizes the 32 countries that implemented a survey in the period between 2010 and 2024 according to criteria that could be used to assess whether a repeat survey in the period 2025–2030 is a priority or not.

Table 6. Countries that implemented a national TB prevalence survey between 2010 and 2024, characterized according to criteria that could be used to assess whether a repeat national TB prevalence survey in the period 2025–2030 is a priority

Country	Meets epidemiological (2023) criteria?[1]	Share (%) of global TB burden (incident cases in 2022)	COVID disruptions mean estimation of burden is extra challenging[2]	Strong country interest in a repeat survey in period up to 2030, with active discussions underway	Funding currently available?	Budget of last survey as % annual funding for TB in 2022	Suitable national agency to lead survey preparations & implementation could be identified	Required laboratory capacity currently exists (especially for MGIT culture)	Participation rate (%) in last survey	Other options	Comments
WHO African Region											
Eswatini	Yes	<0.05%	Yes	No	?	3.4	?	Yes	79%		
Ethiopia	Yes	1.5%	No	Yes	No	0.83	Yes		90%		
The Gambia	No, burden too low	<0.05%	No	NA	NA	NA	NA	NA	77%		
Ghana	Yes	0.41%	No	Yes	No	2.6	Yes	Yes	91%		
Kenya	Yes	1.2%	Yes	Yes	No	1.5	Yes	Yes	83%		
Lesotho	Yes	0.14%	Yes	No	-	9.4		Yes	81%		
Malawi	Yes	0.24%	No	No	No	2.0			81%		
Mozambique	Yes	1.1%	No	No	-	2.2			75%		Current estimates show flat trend, in absence of data to estimate trends
Namibia	Yes	0.13%	Yes	No	?	6.2			77%		
Nigeria	Yes	4.6%	No	Yes	No	0.24	Yes	Yes	57%		Current estimates show flat trend, in absence of data to estimate trends; recent trends in case notifications suggestion major improvement in TB treatment coverage since 2021
Rwanda	No, burden too low	0.07%	No	NA	NA	2.6	NA		96%		
South Africa	Yes	2.7%	No	No	-	0.26	Yes	Yes	66%		
Uganda	Yes	0.88%	No	Yes	Possibly via CAST	0.92	Yes	Yes	91%		Current estimates show flat trend, in absence of data to estimate trends
UR Tanzania	Yes	1.2%	No	Yes	No	1.3			77%		
Zambia	Yes	0.55%	No	Yes	No	2.1			84%		
Zimbabwe	Yes	0.32%	Yes	No	No	?	Yes		78%		

[1] Estimated prevalence of bacteriologically confirmed TB ≥250 per 100 000 population aged ≥15 years during the previous survey and about 10 years since the last survey

[2] If a country or regional specific model was implemented to estimate TB burden in 2023.

Table 6 (continued). Countries that implemented a national TB prevalence survey between 2010 and 2024, characterized according to criteria that could be used to assess whether a repeat national TB prevalence survey in the period 2025–2030 is a priority

Country	Meets epidemiological criteria?[1]	Share (%) of global TB burden (incident cases in 2022)	COVID disruptions mean estimation of burden is extra challenging[2]	Strong country interest in a repeat survey in period up to 2030, with active discussions underway	Funding currently available?	Budget of last survey as % annual funding for TB in 2022	Suitable national agency to lead survey preparations & implementation could be identified	Required laboratory capacity currently exists (especially for MGIT culture)	Participation rate (%) in last survey	Other options	Comments
WHO Eastern Mediterranean, South-East Asia and Western Pacific regions											
Bangladesh	Yes	3.5%	-	Yes	No	0.48	Yes	Yes	91%		Current estimates show flat trend, in absence of data to estimate trends
Cambodia	No last survey 2024	0.51%	Yes	NA	NA	1.4	Yes	Yes	76%		3 surveys already done (2002, 2011, 2023-24)
China	No burden too low	7.0%	No	No	NA	0.12%	Yes	Yes	96%	Inventory study	Inventory study already used
DPR Korea	Yes	1.3%	No	No	?	?	Yes	No access to Xpert Ultra	84%		Current estimates show flat trend, in absence of data to estimate trends
India	Marginal last survey 2021	26%	Yes	No		0.37	Yes	Yes	91%		
Indonesia	Yes	10%	Yes	Yes	No	0.26	Yes	Yes	89%	Inventory study	2017, 2023
Lao PDR	Yes	0.09%	No	No	No	4.9		No	85%		
Mongolia	Yes	0.15%	Yes	No		1.2			84%	Inventory study	Inventory study being considered
Myanmar	Yes	2.4%	Yes	No		1.0	Yes		89%		
Nepal	Yes	0.64%	Yes	No		2.5					
Pakistan	Yes	6.3%	Yes	Yes	No	1.3	Yes	Yes	81%		
Philippines	Yes	6.7%	Yes	No		0.20	Yes		76%		Inventory study planned
Sudan	No burden too low	0.25%	No	No		3.0	Yes		86%		
Thailand	No burden too low	1.0%	Yes	Yes	No	0.38			79%	UHC SCI, inventory study	Only HBC with UHC SCI of 80 or above, and very low level of catastrophic expenditures on health (2%)
Timor-Leste	No last survey 2023	0.06%	Yes	NA	NA	2.2			76%		
Viet Nam	Yes	1.7%	Yes	Yes	No	0.31	Yes		71%		Government decree has called for a 3rd survey

[1] Estimated prevalence of bacteriologically confirmed TB ≥250 per 100 000 population aged ≥15 years during the previous survey and about 10 years since the last survey
[2] If a country or regional specific model was implemented to estimate TB burden in 2023.

8. References

1 World Health Organisation. Global tuberculosis report. Geneva, Switzerland: World Health Organisation; 2023 (https://iris.who.int/handle/10665/373828).

2 Law I, Floyd K, African TB Prevalence Survey group. National tuberculosis prevalence surveys in Africa, 2008–2016: an overview of results and lessons learned. Trop Med Int Health. 2020;25:1308-27. doi: https://doi.org/10.1111/tmi.13485.

3 Onozaki I, Law I, Sismanidis C, Zignol M, Glaziou P, Floyd K. National tuberculosis prevalence surveys in Asia, 1990–2012: an overview of results and lessons learned. Trop Med Int Health. 2015;20:1128-45. doi: https://doi.org/10.1111/tmi.12534.

4 National tuberculosis prevalence surveys, 2007–2016. Geneva: World Health Organization; 2021 (https://www.who.int/publications/i/item/9789240022430).

5 Tuberculosis prevalence surveys: a handbook. Geneva: World Health Organization; 2011 (https://apps.who.int/iris/bitstream/handle/10665/44481/9789241548168_eng.pdf).

6 Global tuberculosis report. Geneva: World Health Organization; 2023 (https://iris.who.int/handle/10665/373828).

7 TB mortality [website]. Geneva: World Health Organization, Global Tuberculosis Programme; 2023 (https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2023/tb-disease-burden/1-2-tb-mortality).

8 TB incidence [website]. Geneva: World Health Organization, Global Tuberculosis Programme; 2023 (https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2023/tb-disease-burden/1-1-tb-incidence).

9 National TB prevalence surveys [website]. Geneva: World Health Organization, Global Tuberculosis Programme; 2023 (https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2023/tb-disease-burden/1-4-tb-prevalence-surveys).

10 Mikkelsen L, Hooper J, Adair T, Badr A, Lopez AD. Comparative performance of national civil registration and vital statistics systems: a global assessment. Bull World Health Organ. 2023;101:758-67. doi: https://doi.org/10.2471/BLT.22.289033.

11 World Health Organization. National tuberculosis prevalence surveys: what diagnostic algorithm(s) should used in future surveys? Geneva, Switzerland: 2023 (https://iris.who.int/handle/10665/367909).

12 Zifodya JS, Kreniske JS, Schiller I, Kohli M, Dendukuri N, Schumacher SG et al. Xpert Ultra versus Xpert MTB/RIF for pulmonary tuberculosis and rifampicin resistance in adults with presumptive pulmonary tuberculosis. Cochrane Database Syst Rev. 2021;2:CD009593. doi: https://doi.org/10.1002/14651858.CD009593.pub5.

13 Roelsgaard E, Iversen E, Blocher C. Tuberculosis in Tropical Africa. An Epidemiological Study. Bull World Health Organ. 1964;30:459-518.

14 World Health Organization. Assessing tuberculosis prevalence through population-based surveys. Geneva, Switzerland 2007 (https://iris.who.int/handle/10665/206962).

15 World Health Organization. Tuberculosis prevalence surveys: a handbook. Geneva, Switzerland: 2011 (https://iris.who.int/handle/10665/44481).

16 Ministry of Health Zimbabwe. The Zimbabwe national population based tuberculosis prevalence survey. 2014.

17 Sustainable Development Goals: the 17 goals [website]. New York: United Nations Department of Economic and Social Affairs; 2023 (https://sdgs.un.org/goals).

18 WHO Global Task Force on TB Impact Measurement. Report of the sixth meeting of the full Task Force (19–21 April 2016, Glion-sur-Montreux, Switzerland). Geneva: World Health Organization; 2016 (https://cdn.who.int/media/docs/default-source/hq-tuberculosis/global-task-force-on-tb-impact-measurement/meetings/2016-05/tf6_report.pdf?sfvrsn=8a9563a3_3).

19 Sustainable development report – SDG 3 indicator: univeral health coverage (UHC) index of service coverage [website]. 2023 (https://dashboards.sdgindex.org/map/indicators/universal-health-coverage-uhc-index-of-service-coverage).

20 WHO consolidated guidelines on tuberculosis. Module 1: Tuberculosis surveillance. Web Annex B. Standards and benchmarks for tuberculosis surveillance and vital registration systems: checklist (2nd edition). Geneva: World Health Organization; 2024.

21 World Health Organization. National tuberculosis prevalence surveys, 2007–2016. Geneva, Switzerland 2021 (https://iris.who.int/handle/10665/341072).
22 Ministry of Health Cambodia. Final report of the national TB prevalence survey, Cambodia 2002. Phnom Penh: CENAT; 2005.
23 Wang L, Zhang H, Ruan Y, Chin DP, Xia Y, Cheng S et al. Tuberculosis prevalence in China, 1990-2010; a longitudinal analysis of national survey data. Lancet. 2014;383:2057-64. doi: https://doi.org/10.1016/s0140-6736(13)62639-2.
24 Tupasi TE, Radhakrishna S, Chua JA, Mangubat NV, Guilatco R, Galipot M et al. Significant decline in the tuberculosis burden in the Philippines ten years after initiating DOTS. Int J Tuberc Lung Dis. 2009;13:1224-30.
25 Tupasi TE, Radhakrishna S, Rivera AB, Pascual ML, Quelapio MI, Co VM et al. The 1997 Nationwide Tuberculosis Prevalence Survey in the Philippines. Int J Tuberc Lung Dis. 1999;3:471-7.
26 Hoa NB, Sy DN, Nhung NV, Tiemersma EW, Borgdorff MW, Cobelens FG. National survey of tuberculosis prevalence in Viet Nam. Bull World Health Organ. 2010;88:273-80. doi: https://doi.org/10.2471/blt.09.067801.
27 World Health Organization. Consolidated guidance on tuberculosis data generation and use: module 3: national tuberculosis prevalence surveys. Geneva, Switzerland: World Health Organisation,; 2024 (in press).
28 World Health Organization. Assessing tuberculosis under-reporting through inventory studies. Geneva, Switzerland:2014 (https://iris.who.int/handle/10665/78073).