Table 1. Main characteristics of national TB prevalence surveys completed in Africa, 2008-2016

Country and year	Residency criteria	Geographical area excluded[a]	Number of clusters	Stratified sampling	Planned sample size	Screening strategy[d] Symptoms interview	Screening strategy[d] Chest X-ray	Smear	Culture	Xpert MTB/RIF	Duration of field operations (months)
Ethiopia 2010-2011	Permanent residents who stayed in the household at lease one night during the 14 days prior to the census day. Temporary visitors who stayed in the household at least 14 days prior to the census day.	37/810 woredas excluded from the sampling frame due to security and logistical challenges.	85	Urban/ Rural/ Pastoralist	46,514	Cough 2 weeks or more	Lung abnormality[f]	2 FM	1 LJ	No	9
Gambia 2012	Residents who spent at least one night in the household in the last 4 weeks before the census. Visitors who arrived in the household 4 weeks or more before the census.	None	80	No	55,281	1) Cough 2 weeks or more 2) Any participant with a cough lasting <2 weeks and 2 or more other symptoms 3) Any participant without a cough AND 3 or more other symptoms[e]	Abnormal and suggestive of TB for any abnormality in lung field or mediastinum[f]	2 FM	2 MGIT	No	14
Ghana 2013	Residents who have not been away for 2 weeks or more.	None	98	Urban/Rural	64,000	Cough 2 weeks or more	Lung abnormality[f]	2 ZN[g]	2 MGIT	Smear-positive or contaminated cultures	10
Kenya 2015-2016	Residents who lived in the household for a minimum of 30 consecutive days prior to the census.	One cluster excluded due to security issues	99[b]	Urban/Rural	72,000	Cough 2 weeks or more	Lung abnormality[f]	2 FM	2 LJ	At least one Xpert test for all participants who screened positive	12
Malawi 2013	Residents who spent at least 14 days in the household before the census.	None	74	Urban/Semi-urban/Rural	37,200	Any symptom for 7 days or longer: cough, cough with sputum, blood stained sputum, chest pain, body weight loss, night sweat, fatigue/malaise, fever, shortness of breath	Lung abnormality	2 FM[h]	2 LJ	Smear-positive or contaminated cultures	11
Nigeria 2012	Slept in the household for 14 days or more.	Three clusters replaced due to security issues	70	Zonal (6)	49,000	Cough 2 weeks or more	Lung abnormality	2 ZN	2 LJ	No	9
Rwanda 2012	Residents who lived in the household for at least 1 month prior to interview.	None	73	No	44,500	Cough (any duration)	Lung abnormality	2 FM	2 LJ	No	10
Sudan 2013-2014	Household resident or visitor for at least 3 weeks.	Four clusters were excluded due to security issues	109[c]	Urban/Rural (Nomadic)	91,131	Cough 2 weeks or more; currently on TB treatment	Lung abnormality[f]	2 FM	2 Ogawa	No	12
Tanzania 2012	A person having slept for the last 2 weeks in the household	None	62	Urban/Rural/ Semi-urban/Zanzibar	46,792	Cough 2 weeks or more, haemoptysis, fever for more than 2 weeks, weight loss, and excessive sweating	Any abnormality in the lung fields or mediastinum	3 FM	1 LJ	No (Smear-positive slides examined retrospectively)	11
Uganda 2014-2015	Individuals who have resided in the household in the survey cluster for at least 14 days before the census day.	None	70	Urban/Rural	40,180	Cough 2 weeks or more	Lung abnormality[f]	2 ZN	2 LJ	Smear-positive or contaminated cultures	10
Zambia 2013-2014	Individuals who have slept in the household in the previous 24 hours prior to census.	None	66	Urban/Rural	54,400	Cough or fever or chest pains for 2 weeks or more	Lung abnormality or chest X-ray indeterminate[f]	2 ZN	2 MGIT	Smear-positive or contaminated cultures	11
Zimbabwe 2014	Permanent residents who had spent a night at the household. Visitors who were residing in the selected cluster for 14 days or more before the survey.	Two clusters were replaced due to logistical issues.	75	Urban/Rural	44,951	Cough of any duration, drenching night sweats, and/or haemoptysis	Lung abnormality[f]	2 FM	2 MGIT	Smear-positive or contaminated cultures	12

CXR: Chest X-ray. C: Conventional radiology. DR: Digital radiology. FM: Flurorescence microscopy. LJ: Löwenstein-Jensen. MGIT: Mycobacterial growth indicator tube. MOH: Ministry of Health. N/A: Not applicable. NTP: National TB Programme. ZN: Ziehl-Neelsen stain.

[a] Although some surveys excluded certain geographical areas from their sampling frames, we included national surveys when most populations were covered.

[b] In Kenya, 1 cluster was excluded from the original 100.

[c] In Sudan, 5 clusters were excluded from the original 114; one for protocol violation and four for security reasons.

[d] Criteria for eligibility of sputum examination.

[e] In Gambia, other symptoms included chest pain, fever, haemoptysis, night sweats, shortness of breathe, loss appetite and weight loss.

[f] Other criteria were used especially if a participant was exempt or refused to have a chest X-ray. Please see supplementary file (**S2 text**) for details.

[g] In Ghana, Zield-Neelsen smears used the concentrated method.

[h] In Malawi, FM smears used the concentrated method.

Table 2. Summary of sampling population, survey participants and screening outcomes

| Country | Timeframe of field operations | Planned sample size | Number of people eligible to participate | Survey participants | | Number and percentage of participants eligible for sputum examination | | | | | | | | | | | | | |
				Number	Participation rate (%)	Symptom positive, chest X-ray positive	%	Symptom positive, chest X-ray negative/N/A	%	Symptom negative, chest X-ray positive	%	Other [a]	%	Any symptom positive	%	Any chest X-ray positive	%	Total eligible	%
Ethiopia	2010–2011	46 514	51 667	46 697	90%	806	1.7%	2220	4.8%	3013	6.5%	41	0.09%	3026	6.5%	3819	8.2%	6080	13%
Gambia	2011–2013	55 281	55 832	43 100	77%	1026	2.4%	2436	5.7%	2384	5.5%	102	0.24%	3462	8.0%	3410	7.9%	5948	14%
Ghana	2013	63 905	67 757	61 726	91%	771	1.2%	1198	1.9%	4387	7.1%	1942	3.1%	1969	3.2%	5158	8.4%	8298	13%
Kenya	2015–2016	72 000	76 291	63 050	83%	1241	2.0%	2896	4.6%	5184	8.2%	394	0.62%	4137	6.6%	6425	10%	9715	15%
Malawi	2013–2014	37 200	39 026	31 579	81%	381	1.2%	2334	7.4%	717	2.3%	N/A	N/A	2715	8.6%	1098	3.5%	3432	11%
Nigeria	2012	49 000	77 797	44 186	57%	746	1.7%	1720	3.9%	2222	5.0%	N/A	N/A	2466	5.6%	2968	6.7%	4688	11%
Rwanda	2012	44 500	45 058	43 128	96%	545	1.3%	2092	4.9%	2107	4.9%	3	0.01%	2637	6.1%	2652	6.1%	4747	11%
Sudan	2013–2014	91 131	96 979	83 202	86%	1823	2.2%	840	1.0%	9838	12%	5040	6.1%	2663	3.2%	11 661	14%	17 541	21%
Uganda	2014–2015	40 180	45 293	41 154	91%	552	1.3%	2162	5.3%	2298	5.6%	130	0.32%	2714	6.6%	2850	6.9%	5142	12%
Tanzania	2011–2012	46 792	65 664	50 447	77%	804	1.6%	3459	6.9%	2039	4.0%	N/A	N/A	4263	8.5%	2843	5.6%	6302	12%
Zambia	2013–2014	54 400	54 830	46 099	84%	1505	3.3%	2948	6.4%	2255	4.9%	N/A	N/A	4453	10%	3760	8.2%	6708	15%
Zimbabwe	2014	44 951	43 478	33 736	78%	628	1.9%	1205	3.6%	2803	8.3%	1184	3.5%	1833	5.4%	3431	10%	5820	17%
Total					83%		1.8%		4.7%		6.2%		1.7%		6.5%		8.0%		14%

N/A, not applicable.

[a] Other refers to criteria used to ascertain if a participant was eligible for sputum collection other than via symptom or chest X-ray screening. See **S2 Text** for specific details.

Table 3. Summary of prevalent TB cases and the prevalence of pulmonary TB per 100 000 population aged ≥15 years

Country	Smear-positive pulmonary TB				Bacteriologically confirmed pulmonary TB				Proportion of bacteriologically confirmed cases that were smear-positive
	Number of cases	Prevalence per 100 000 population aged ≥15 years[a]	95% confidence interval	k[b]	Number of cases	Prevalence per 100 000 population aged ≥15 years[a]	95% confidence interval	k[b]	
Ethiopia	47	108	73–143	0.7	110	277	208–347	0.4	39
Gambia	34	90	53–127	1.3	77	212	152–272	0.7	42
Ghana	64	111	76–145	0.9	202	356	288–425	0.7	31
Kenya	123	230	174–286	0.7	305	558	455–662	0.7	41
Malawi	62	220	142–297	1.1	132	452	312–593	1.1	49
Nigeria	107	318	225–412	0.9	144	524	378–670	0.7	61
Rwanda	27	74	48–99	N/A[c]	40	119	79–160	0.7	62
Sudan	57	87	52–121	1.3	112	183	128–238	1.3	48
Uganda	66	174	111–238	0.9	160	401	292–509	0.8	43
Tanzania[d]	134	275	232–326	0.6	N/A	N/A	N/A	N/A	N/A
Zambia	135	319	232–406	0.8	265	638	502–774	0.7	50
Zimbabwe	23	82	47–118	N/A[c]	107	344	268–420	0.3	24

N/A, not applicable.

[a] Estimates based on the use of robust standard errors with missing value imputation and inverse probability weighting for all countries except for Tanzania for which a cluster-level analytical model was used.

[b] k is the coefficient of variation of the cluster-specific TB prevalences. When the coefficient of variation (k) of cluster-specific TB prevalence was not reported, it was derived from the reported design effect.

[c] k could not be calculated because the design effect was less than one.

[d] The number of bacteriologically-confirmed cases could not be verified for the estimation of prevalence by WHO. The smear-positive and bacteriologically-confirmed prevalence reported by the Tanzanian survey team was 249 per 100 000 (95%CI: 192–305) and 293 per 100 000 (95%CI: 228–358) population, respectively. (Senkoro et al, 2016).

Table 4. Percentage of survey participants with smear-positive results that were not confirmed TB. Results shown for surveys in which specimens were tested using smear microscopy, rapid molecular tests and culture.[a]

Country	Number of participants with at least one smear-positive specimen	Participants with smear-positive specimens excluded as a TB case	
		Number	%
Ghana	198	138	70%
Kenya	141	18	13%
Malawi	163	101	62%
Sudan	61	4	6.6%
Uganda	91	25	27%
Zambia	356	221	62%
Zimbabwe	206	183	89%

[a] Results are shown for surveys in which specimens were systematically tested using smear microscopy and rapid molecular tests. All surveys used Xpert MTB/RIF except Sudan which used line probe assays (LPAs). Kenya used both culture and Xpert MTB/RIF whereas other surveys used Xpert (or LPA) to confirm smear-positive specimens only.

Table 5. Health care-seeking behaviour among participants who were symptom-screen positive

Country	Participants who were symptom-screen positive	No action taken	%	Location of care sought																		
				Consulted medical facility	%	Type of facility						Pharmacy	%	Traditional	%	Other	%	Unspecified	%	Self-treated	%	Unknown	%
						Public facility	%	Private facility	%	Other facility	%												
Ethiopia	3026	1932	64%	848	28%	628	74%	199	23%	21	2.5%	40	1.3%	3	0.10%	N/A	N/A	55	1.8%	N/A	N/A	148	4.8%
Gambia	3462	1424	41%	1706	49%	1398	82%	220	13%	88	5.2%	17	0.49%	14	0.40%	24	0.69%	N/A	N/A	N/A	N/A	277	8.0%
Ghana	1969	264	13%	793	40%	695	88%	61	7.7%	37	4.7%	324	17%	20	1.0%	N/A	N/A	N/A	N/A	567	29%	1	0.10%
Kenya[a]	4137	2763	67%	1257	30%	1047	N/A	198	N/A	3	N/A	56	N/A	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	117	2.8%
Malawi	2715	1096	40%	1280	47%	901	70%	379	30%	N/A	N/A	32	1.2%	41	1.5%	4	0.15%	N/A	N/A	236	8.7%	26	0.96%
Nigeria	2466	604	24%	800	32%	628	79%	172	21%	N/A	N/A	319	13%	11	0.45%	9	0.36%	3	0.12%	680	28%	40	1.6%
Rwanda[a]	2855	1934	68%	921	32%	941	N/A	48	N/A	38	N/A	101	N/A	54	N/A	N/A	N/A	N/A	N/A	0	0	N/A	N/A
Sudan	2663	575	22%	1308	49%	1077	82%	90	6.9%	141	11%	52	2.0%	49	1.8%	N/A	N/A	69	2.6%	N/A	N/A	610	23%
Uganda	2714	1059	39%	1201	44%	1038	86%	146	12%	17	1.4%	421	16%	11	0.41%	N/A	N/A	N/A	N/A	22	0.81%	0	0%
Tanzania	3388	1688	50%	481	14%	445	93%	36	7.5%	N/A	N/A	147	4.3%	11	0.32%	257	7.6%	155	4.6%	N/A	N/A	649	19%
Zambia	4453	2534	57%	1829	41%	1680	92%	75	4.1%	74	4.0%	16	0.36%	1	0.02%	N/A	N/A	N/A	N/A	N/A	N/A	73	1.6%
Zimbabwe[a]	1833	1130	62%	486	26%	438	N/A	45	N/A	N/A	N/A	17	N/A	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	217	12%

N/A, not applicable.

[a] In Kenya, Rwanda and Zimbabwe participants could select more than one category.

Table S1: risk of bias [1] as assessed by author (IL)

		Ethiopia	Gambia	Ghana	Kenya	Malawi	Nigeria	Rwanda	Sudan	Tanzania	Uganda	Zambia	Zimbabwe	Comments
1	Was the study's target population a close representation of the national population in relation to relevant variables, e.g. age, sex, occupation?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	The survey census was similar in proportion to the national population with respect to age and sex of those 15 years and above.
2	Was the sampling frame a true or close representation of the target population?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Ethiopia, Kenya, Nigeria and Sudan had to exclude a few areas or clusters due to security issues, but the sampling frame was still deemed to be representative of the target population.
3	Was some form of random selection used to select the sample, or, was a census undertaken?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	A census was undertaken at each cluster site for each survey.
4	Was the likelihood of non-response bias minimal?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Nigeria's participation rate was only 57%. As with all surveys, multiple imputation methods accounted for missingness in order to estimate prevalence.
5	Were data collected directly from the subjects (as opposed to a proxy)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Data were directly collected from all participants who consented to participate.
6	Was an acceptable case definition used in the study?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	The original case definition of a survey TB case used bacteriological confirmation methods that could not be verified. Therefore for this paper, an amended case definition using smear-positive TB results was used instead. See methods.
7	Was the study instrument that measured the parameter of interest (e.g. prevalence of low back pain) shown to have reliability and validity (if necessary)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	All surveys underwent extensive interviewer testing and also pilot testing prior to field operations. Tools were in accordance with WHO guidance (WHO TB prevalence survey handbook, 2011).
8	Was the same mode of data collection used for all subjects?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	All surveys undertook the same method as per WHO guidance (WHO TB prevalence survey handbook, 2011) i.e. screening via interview and chest X-ray, followed by laboratory test confirmed for those that screened positive.
9	Was the length of the shortest prevalence period for the parameter of interest appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	All surveys asked about symptoms and their duration within the past 2-3 weeks. Chest X-ray was undertaken at the time of screening.
10	Were the numerator(s) and denominator(s) for the parameter of interest appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Extensive verification of all numerators (cases) and denominators was made during the survey. Missng data were imputed during the analytical phase.
11	Summary item on the overall risk of bias	Low risk of bias - further research is very unlikely to change our confidence in the estimate.												

[1] Source: Appendix 1 from Hoy D, Brooks P, Woolf A, et al. Assessing risk of bias in prevalence studies: modification of an existing tool and evidence of interrater agreement. J Clin Epidemiol. 2012;65(9):934-939. doi:10.1016/j.jclinepi.2011.11.014

Table S2. Bacteriologically-confirmed TB survey cases by age group in national TB prevalence surveys implemented in Africa 2008–2016: prevalence and number

Prevalence per 100 000 population

Country	Age group (years) 15-24	25-34	35-44	45-54	55-64	≥65
Ethiopia	292	216	259	337	367	227
Gambia [a]	133	n/a	355	n/a	329	n/a
Ghana	185	228	295	470	607	908
Kenya	360	716	602	607	587	576
Malawi	120	315	902	309	800	1564
Nigeria	274	496	613	750	599	660
Rwanda [a]	86	n/a	114	n/a	262	n/a
Sudan	50	239	253	226	252	280
Tanzania [b]	51	280	316	241	462	662
Uganda	228	442	624	565	636	570
Zambia	285	664	947	926	708	876
Zimbabwe	129	373	546	310	490	547

Number of TB cases

Country	Age group (years) 15-24	25-34	35-44	45-54	55-64	≥65	Total TB cases
Ethiopia	36	24	18	16	11	5	110
Gambia	15	14	19	11	8	10	77
Ghana	29	29	30	37	30	47	202
Kenya	54	90	58	43	28	32	305
Malawi	12	21	35	10	17	37	132
Nigeria	19	35	30	29	15	16	144
Rwanda	8	7	7	5	9	4	40
Sudan	8	32	28	17	13	14	112
Tanzania [b]	7	29	28	16	21	33	134
Uganda	29	42	39	24	12	14	160
Zambia	32	66	68	45	23	31	265
Zimbabwe	11	28	30	10	13	15	107

[a] For Gambia and Rwanda, rates were only calculated for three age groups: 15-34, 35-54 and ≥55 years.

[b] Bacteriologically-confirmed TB cases could not be verified, therefore only smear-positive TB cases were included in the analysis.

Table S3. Prevalent TB cases by screening outcome in national TB prevalence surveys implemented in Africa 2008–2016

Country	Number (%) of prevalent TB cases by screening outcome								
	Symptoms only	%	X-ray only	%	Symptoms and X-ray	%	Other [a]	%	Total
Ethiopia	12	10.9	53	48.2	45	40.9	0	0	110
Gambia	12	15.6	33	42.9	32	41.6	0	0	77
Ghana	15	7.4	85	42.1	67	33.2	35	17.3	202
Kenya	32	10.5	154	50.5	115	37.7	4	1.3	305
Malawi	67	50.8	40	30.3	25	18.9	N/A	N/A	132
Nigeria	16	11.1	52	36.1	76	52.8	N/A	N/A	144
Rwanda	4	10.0	21	52.5	15	37.5	0	0.0	40
Sudan	8	7.1	45	40.2	43	38.4	16	14.3	112
Tanzania	18	13.4	48	35.8	55	41.0	13	9.7	134
Uganda	16	10.0	81	50.6	63	39.4	0	0	160
Zambia	46	17.4	104	39.2	115	43.4	N/A	N/A	265
Zimbabwe	10	9.3	64	59.8	29	27.1	4	3.7	107

[a] Other refers to criteria used to ascertain if a participant was eligible for sputum collection other than via symptom or chest X-ray screening. See supplementary file (**Text S2**) for specific details.
In Tanzania, 13 people screened negative, and were not part of the total number eligible for sputum examination. The reason for their sputum submission was not known.

Table S4. Location of treatment for participants who were on treatment at the time the survey was implemented, 2008–2016

Country	Number of participants who were on TB treatment at the time of the survey	Public sector	%	Private sector	%	Other sector	%	Unknown sector	%
Ethiopia	75	54	72%	7	9.3%	3	4.0%	11	15%
Gambia	38	38	100%	0	0%	0	0%	0	0%
Ghana	48	42	88%	1	2.1%	5	10%	0	0%
Kenya[a]	62	23	37%	0	0%	1	1.6%	38	61%
Malawi[a]	12	10	83%	2	17%	0	0%	0	0%
Nigeria	82	56	68%	14	17%	5	6.1%	7	8.5%
Sudan	104	69	66%	1	1.0%	4	3.8%	30	29%
Uganda	61	57	93%	4	6.6%	0	0%	0	0%
Zambia	114	61	54%	1	0.9%	0	0%	52	46%

[a] In Kenya and Malawi, data were available only for participants who were eligible for sputum submission.

Table S5. Major successes of national TB prevalence surveys implemented in Africa 2008–2016

Country	First national survey completed (ever or for many years)[a]	Up-to-date direct measurement of TB disease burden and other valuable information about the status of the TB epidemic and access to care provided	High participation rate (>80%)	Good data management	Strong laboratory	Timely finalization and dissemination of results
Ethiopia	x	x	x			
Gambia	x	x			x	
Ghana	x	x	x	x		
Kenya	x	x	x			
Malawi	x	x	x	x		x
Nigeria	x	x				
Rwanda	x	x	x			
Sudan	x	x	x			
Uganda	x	x	x	x	x	x
Tanzania	x	x				
Zambia	x	x	x	x		x
Zimbabwe	x	x			x	x

Table S6. Major challenges faced in national TB prevalence surveys implemented in Africa 2008–2016

Country	Time to secure funding or funding interruptions during survey	Lengthy process to procure X-ray equipment	Security issues	Participation rate (≤80%)[a]	Overheating or breakdown of X-ray machines during field operations	Data management	Laboratory work (primarily issues related to culture testing)	Delays in central reading of X-rays or difficulties in retaining radiologists	Delays in writing the survey report
Ethiopia		x				x	x	x	
Gambia		x		x					x
Ghana		x			x		x	x	x
Kenya		x				x		x	
Malawi	x				x		x	x	x
Nigeria			x	x		x	x		x
Rwanda		x				x	x		
Sudan			x		x	x	x		
Uganda	x				x				
Tanzania	x					x	x		x
Zambia									
Zimbabwe					x	x		x	

[a] In addition, several countries reported challenges with participation in at least one of the following subcategories: the first survey clusters, younger age groups, men and urban (especially wealthier) areas.