

Comparing MiniDock MTB, chest radiography, and symptoms for tuberculosis screening: a community-based evaluation in Karachi, Pakistan

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Abstract

Background

Community-based active case finding (ACF) for tuberculosis (TB) is constrained by limited access to chest X-ray (CXR) and reliance on sputum-based diagnostic testing. Recently, WHO recommended near point-of-care testing which offers a non-sputum alternative, tongue swab (TS). We evaluated the feasibility and screening performance of MiniDock MTB on TS compared with WHO four-symptom screening (W4SS) and CXR in Pakistan.

Methods

We conducted 49 screening camps in underserved communities of Karachi. All adolescents and adults (> 10 years) underwent screening via W4SS, CXR, and TS collection. Individuals screening positive by any method were asked to provide sputum for Xpert MTB/RIF Ultra, sputum swab testing on MiniDock MTB, and mycobacterial culture. A microbiological reference standard (MRS) was defined as a positive Xpert MTB/RIF Ultra and/or mycobacterial culture.

Results

Overall, 4,303 individuals were screened (median age 28 years [IQR 16–40]); 38% were female. All participants had CXR and W4SS screening results, while 3,432 (79.8%) had valid TS results. Overall, 752 participants were screen-positive for TB, including 606 with valid TS results. TS was positive in 19/3,432 (0.4%), CXR in 302/4303 (7.0%) and W4SS in 522/4,303 (12.1%). Sputum was collected from 243 (32%) of 752 screen-positive participants, including 225 (37%) with valid TS results; Among 30 MRS-positive individuals, 29 had abnormal CXR, 14 had symptoms and 13 a positive TS result. CXR showed the highest sensitivity (96.7%; 95% CI 82.8–99.9), compared with W4SS (46.7%; 95% CI 28.3–65.7) and TS testing (46.4%; 95% CI 27.5–66.1).

Conclusion

TS testing, although feasible, was not sufficiently sensitive to function as a standalone TB screening test. Further optimization of specimen collection, assay performance, and evaluation in diverse settings is needed to better define the role of TS testing in community-based TB screening.

Introduction

Tuberculosis (TB) is a major yet preventable airborne infectious disease. About one fourth of the world's population is infected with TB bacilli, the vast majority of whom have no disease. In 2024, an estimated 10.7 million new TB cases emerged worldwide, and more than 1.2 million people died of TB, making it

the leading single infectious disease cause of death. Notably, a substantial gaps persist in TB detection and reporting, with an estimated 2.4 million incident cases in 2024 remaining undiagnosed or unreported(1).

Persistent case-detection gaps and diagnostic delays demonstrate the limitations of passive case-finding strategies and highlight the need for more proactive approaches to TB detection, particularly among vulnerable and hard-to-reach populations(2). One such approach is systematic screening for TB disease(3, 4), a key component of the first pillar of the WHO End TB Strategy which focuses on early diagnosis and treatment(5). Active case finding (ACF) aims to diagnose individuals with TB earlier, thereby reducing diagnostic and treatment delays, improving patient outcomes, and mitigating the social and economic consequences of disease. At the population level, it contributes to reducing the burden of undiagnosed TB and interrupting ongoing community transmission (6, 7).

To support the implementation of systematic TB screening, the WHO updated its evidence-based screening guidelines in 2021(6). These guidelines recommend systematic screening for well-defined high-risk groups, including people living with HIV(PLHIV), household contacts, prisoners, miners, and silica-exposed workers, as well as the general population in settings with an estimated TB prevalence of $\geq 0.5\%$. Screening is also recommended for underserved populations facing structural barriers to healthcare, such as urban poor communities, migrants, refugees, internally displaced persons, and geographically isolated populations (6). In 2025, WHO updated the target product profile (TPP) for TB screening tests and defined performance characteristics to guide the development of scalable, low-cost screening tests with meaningful public health impact(8).

Currently, the WHO recommends systematic TB screening among individuals aged ≥ 15 years using symptom screening, chest X-ray (CXR), or WHO-recommended rapid molecular diagnostic (WRD) tests, alone or in combination(6). CXR is a cornerstone for TB screening because of its ability to detect asymptomatic disease and is used in all modern TB prevalence surveys (9, 10). However, access to CXR is limited by high costs, radiation exposure, the need for trained readers or artificial intelligence, and the operational challenges of maintaining imaging equipment hardware and software in remote settings(6, 9–11).

A simple, non-invasive screening test capable of detecting asymptomatic TB would be valuable for community outreach. However, bacteriological confirmation of TB still relies largely on sputum-based testing, limiting diagnosis among individuals unable to produce an adequate sputum specimen. Sputum scarcity has been reported in nearly one-quarter of presumptive TB patients in facility-based studies(12) and is likely to be even more common during community-based screening, where many presumptive TB cases are identified by abnormal CXR in the absence of symptoms, reflecting the high burden of subclinical disease(13). These challenges have driven increasing interest in the development and evaluation of non-sputum-based diagnostic approaches for TB (14, 15).

In early 2026, WHO recommended the first-in-class swab-based near point-of-care nucleic acid amplification test (NPOC-NAAT) for the diagnosis of TB, Pluslife's MiniDock MTB assay (Guangzhou

Pluslife Biotech, China)(16). In addition to sensitivity comparable to Xpert MTB/RIF Ultra (Xpert Ultra) assay (Cepheid, Sunnyvale, CA, USA), in facility-based studies (17–21), the platform offers several operational advantages, including lower cost, rapid turnaround time (approximately 30 minutes), and battery-powered operation, suitable for decentralized settings. These features support its potential use in community-based TB screening, particularly in resource-limited and hard-to-reach settings. However, evidence on its feasibility and performance under community settings remain limited.

Pakistan is among the five countries with the highest burden of tuberculosis globally. According to the WHO Global Tuberculosis Report 2025, an estimated 669,000 incident TB cases occurred in Pakistan in 2024, corresponding to an incidence rate of 266 per 100,000 population. During the same year, 497,000 TB cases were notified, leaving an estimated gap of approximately 172,000 undiagnosed or unnotified TB cases (1). Against this backdrop, we conducted a study to evaluate the feasibility and screening performance of tongue swab (TS) based testing using the MiniDock MTB NPOC assay as a non-sputum TB screening tool in community-based ACF, and to compare its yield and performance with symptom and AI-assisted CXR screening.

Methods

Study design and implementation

The cross-sectional study was conducted within an integrated community-based TB screening and lung health service delivery model. ACF activities were implemented through screening camps between 25 August and 5 November 2025.

Study setting/population

The study was conducted in Keamari, a coastal district of Karachi, Pakistan, with a population of approximately 2.0 million distributed across the mainland and three islands(22). The district comprises densely populated, predominantly low-income communities with largely informal housing and limited access to basic healthcare services. Fishing, port-related activities, and daily wage labour are the main sources of livelihood. The use of smokeless tobacco products, including paan, betel nut, and related chewing products, was noted among participants during implementation, reflecting common practices in parts of Pakistan and other Asian countries (23). In 2024, 41% (2,283/5,502) of the estimated TB cases in Keamari were notified (unpublished TB Programme data), compared with approximately 74% nationally (1).

Screening procedures

All participants aged ≥ 10 years were eligible for inclusion and were registered upon arrival at the screening camps. At registration, participants were informed about the study objectives and procedures,

and informed consent was obtained prior to enrolment.

All consenting participants were first screened using the WHO-recommended four-symptom screen (W4SS), for cough, fever, night sweats, and weight loss. In addition, history was obtained of prior TB treatment and relevant comorbidities. All participants then underwent chest radiography, performed using an ultra-portable digital X-ray system (IMPACT, MinXray Inc., Northbrook, Illinois, USA). CXR images were analyzed onsite using computer-aided detection (CAD) software qXR version 3.2, (Qure.ai Technologies Pvt. Ltd., Mumbai, India) calibrated to identify radiographic abnormalities suggestive of pulmonary TB with an output of a TB risk score that ranged from 0 to 1. Finally, TS specimens were collected from all participants and tested on-site using the MiniDock MTB platform, following the manufacturer's instructions. Participants were classified as screen positive for TB if they reported any TB symptoms and/or had a predefined CXR TB risk score of ≥ 0.5 , based on the manufacturer's recommendation and previous literature from ACF settings (24), and/or a positive TS MiniDock MTB result. The screen positive individuals were guided to submit two spontaneously expectorated sputum specimens. All specimens collected were transported same day under standard biosafety conditions to the Provincial TB Reference Laboratory (PTRL) in Karachi.

Field operations and workflow

All study procedures, including W4SS, CXR and TS MiniDock MTB screening, were conducted by trained study personnel. Field staffing was organized to ensure efficient workflow and sample handling. Two field staff collected TS specimens, two staff conducted MiniDock MTB testing, and one staff member was responsible for sputum collection from screen positive individuals.

Multiple diagnostic devices were deployed concurrently in the field setup including two Pluslife Thermolyse units and ten MiniDock Ultra integrated nucleic acid testing devices running on battery power to ensure efficient parallel sample processing and rapid turnaround time. Participants were advised to wait on site for screening results.

Central laboratory testing:

In PTPL the first specimen was processed for Xpert Ultra, and sputum swab for MiniDock MTB. The second specimen was processed for culture using the Mycobacterial Growth Indicator Tube (MGIT) system (Becton Dickinson, Franklin Lakes, NJ, USA), and acid-fast bacilli (AFB) smear microscopy. The microbiological reference standard (MRS) was classified as positive if either Xpert Ultra or MGIT culture was positive.

Data management and statistical analysis

A unique study ID was assigned to each participant, demographic, clinical, radiologic, and laboratory data were captured electronically using a customized digital application and stored in a secure

password-protected database.

Descriptive statistics were used to summarize participant characteristics and screening outcomes. Categorical variables were compared using Pearson's χ^2 test, with Fisher's exact test used when expected cell counts were small.

Screening performance of TS, W4SS, and CXR was evaluated against the MRS among participants with complete paired test results. Sensitivity, specificity, positive and negative predictive values (PPV & NPV), and 95% confidence intervals (CIs) were calculated. The number needed to screen (NNS) and number needed to test (NNT) to identify one confirmed TB case were calculated as the number screened and number tested, respectively, divided by the number of confirmed TB cases identified by each screening modality. The prevalence of undiagnosed TB was estimated as the number of confirmed TB cases identified through each screening modality per 100,000 participants screened.

Factors associated with abnormal CXR findings, sputum scarcity, and invalid TS results were explored using univariable and multivariable logistic regression analyses. All analyses were conducted using Stata version 13 (StataCorp, College Station, TX, USA).

Ethical considerations

The study was approved by the National Bioethics Committee (NBC), Islamabad, Pakistan (4–87/NBCR-1231/24–25/1898), and conducted in accordance with national and international ethical guidelines for research involving human participants. Informed consent was obtained from all participants before study procedures. For participants aged < 18 years, written informed consent was obtained from a parent or legal guardian, and assent was obtained from the participant before enrolment. Individuals diagnosed with TB were linked to care and treatment in accordance with National TB Programme guidelines. Participant confidentiality was maintained through restricted database access and the use of de-identified data for analysis.

Results

During the study period, 49 community screening camps were conducted across the coastal district of Keamari, including seven camps in island communities. A total of 4,477 individuals attended the camps (mean 91 participants per camp; range 22–150). Of these, 4,305 individuals aged ≥ 10 years were approached, and 4,303 were enrolled after obtaining informed consent. (Additional file-1, Figure-S1). Participant flow through CXR, W4SS, and MiniDock MTB TS testing, screened positive groups and MRS results is shown in Figure-1.

Participants characteristics

Of 4,303 participants, 1,637 (38%) were female; 32% were aged 10–19 years, 62% aged 20–64 years, and 6% aged ≥ 65 years. Eleven reported a history of TB, and four were known to be HIV-positive (Table 1).

Table 1
Participant demographic and clinical characteristics and screening outcome, by Sex

Participants enrolled	All		Female		Male		p-value
	4303		1637		2666		
Age, median (IQR)	28(16–40)		28(15–45)		28(18–40)		
Age group							
adolescent 10–19 years	1,393	32%	612	37.4%	781	29.3%	< 0.001
adults 20–64 years	2,670	62%	912	55.7%	1758	65.9%	
adult > 65 years	240	6%	113	6.9%	127	4.8%	
Other health condition							
HIV positive	4	0.09%	0	0.0%	4	0.15%	0.305
Diabetes	2	0.05%	1	0.06%	1	0.04%	0.728
Hypertension	1	0.0%	1	0.06%	0	0.00%	0.517
Hepatitis C	1	0.0%	0	0.0%	1	0.0%	
Asthma	38	0.9%	15	0.9%	23	0.86%	
History of TB	11	0.3%	5	0.3%	6	0.2%	0.612
Symptom screening (W4SS)							
Any symptom	522	12.1%	303	18.5%	219	8.2%	< 0.001
One symptom only	262	6.1%	175	12.6%	87	3.0%	< 0.001
Cough ≥2weeks	404	9.4%	217	13.3%	187	7.0%	< 0.001
Fever	290	6.7%	173	10.6%	117	4.4%	< 0.001
Night sweats	86	2.0%	31	1.9%	55	2.1%	0.70
Weight loss	159	3.7%	71	4.3%	88	3.3%	0.08
Chest Xray screening							
CAD score ≥ 0.5(All)	302	7.0%	147	9.0%	155	5.8%	< 0.001
CAD score ≥ 0.5 to 0.75	133	3.1%	81	4.9%	52	2.0%	< 0.001
CAD score > 0.75	169	3.9%	66	4.0%	103	3.9%	
Tongue swab (MiniDock MTB) screening							
TS uptake	3,830	89%	1,462	89.3%	2368	88.8%	0.62
TS valid results	3,432	80%	1,290	78.8%	2142	80.3%	0.029

Participants enrolled	All		Female		Male		p-value
	4303		1637		2666		
TS positive	19	0.40%	1	0.07%	18	0.62%	0.004
Screened Positive group by CXR and W4SS results							
No symptoms & CXR CAD score < 0.5	5	0.2%	0	0.0%	5	0.3%	0.105
Any symptom & CXR CAD score < 0.5	445	10.3%	266	16.2%	179	6.7%	< 0.001
No symptom & CXR CAD score ≥ 0.5	225	5.2%	110	6.7%	115	4.3%	
Any symptom & CXR CAD score ≥ 0.5	77	1.8%	37	2.3%	40	1.5%	
AI Screen positive	752	17.5%	413	25.2%	339	15.5%	< 0.001

IQR, interquartile range; TB, tuberculosis; TS, tongue swab; W4SS, WHO four symptom screening; CXR, Chest X-ray; CAD, computer aided detection; NA, not applicable; Percentages (%) are column percentage unless otherwise indicated.

Symptom screening

All participants underwent verbal symptom screening and chest radiography (CXR). Of the 4303 participants, 522 (12.1%) reported at least one TB-related symptom, most commonly cough ≥ 2 weeks (77.4%), followed by fever (55.6%), weight loss (30.5%), and night sweats (16.5%). Among symptomatic individuals, 50% (262) reported only one symptom of whom 162 (61.8%) reported prolonged cough as the sole symptom. Reporting of a single symptom was more common among females than males (57% vs 40%; $p < 0.001$) (Table-1)

Chest Xray screening

Abnormal CXR findings suggestive of TB (CAD score > 0.5) were reported in 302 (6.9%) participants, of whom 77 (25.5%) also reported TB symptoms. CAD score was > 0.75 in 56% ($n = 169$) of those with abnormal findings. Abnormal CXR findings were more common among females, older participants, and those with a higher symptom burden (66.5% vs. 44.8%; $p < 0.001$) (Additional file-1, Table S1), while higher CAD scores (> 0.75) were more common among males than females (Table-1).

Tongue swab screening using Minidock MTB; Of 4303 participants, 473 (11.0%) declined TS specimen collection. Among 3830 (89.0%) participants who provided TS specimens and were tested using MiniDock MTB, valid results were obtained for 3,432 (89.6%) including 19(0.6%) positive results. (Table 1). Invalid TS results were less common among males than females (aOR 0.75, 95% CI 0.61–0.93)

and among adolescents than adults aged 20–64 years (aOR 0.52, 95% CI 0.41–0.68). Symptom and CXR CAD score were not associated with invalid TS results (Additional file – 1, Table S2).

Screening outcomes

Of 4303 individuals screened, valid results from all three screening methods (W4SS, CXR, and TS) were available for 3,432 (79.8%) participants, while 871 (20.2%) had W4SS and CXR results but not TS.

Overall, 752/4303 (17.5%) individuals screened positive for TB. Among the 3,432 participants with complete results for all three screening methods, 606 (17.7%) screened positive, including eight positives by all three methods, 64 by two methods, and 534 by a single method. TS was positive in 19/606 (3.1%) participants, including five (0.8%) screened positive by TS alone, six of 197 (3.1%) who screened positive by CXR but not W4SS, and eight of 66 (12.1%) who screened positive by both CXR and W4SS. None of the 338 participants who screened positive by symptom screening alone had a positive TS result. (Figure-1).

Among the 871 participants without valid TS results, 146 (16.8%) were screen-positive, including 107(73%) by symptoms alone, 28(19.2%) by CXR alone and 11(7.5%) by both W4SS and CXR.

Screen-positive participants were older than those who screened negative (median age 40 vs 25 years; $p < 0.001$) and more frequently female (55% vs. 34%; $p < 0.001$).

Sputum collection in Screen positive

Among the 752 participants eligible for sputum collection, 68 (9.1%) declined sputum collection. Of the remaining participants, 302 (40.0%) submitted a sputum specimen, of which 243 (81.6%) were of sufficient quantity for Xpert Ultra and sputum swab testing. A second sputum specimen for mycobacterial culture and AFB smear microscopy was obtained from 167 participants (Table 2).

Sputum collection was more successful among participants with abnormal CXR(CAD ≥ 0.5) compared to those with normal CXR (65% vs 28%; p -value < 0.001) (Table-2), whereas female sex, adolescence, and normal CXR findings were associated with inability to provide a sputum specimen (Additional file-1, Table S3).

Table 2

Sputum specimen collection cascade, valid test results, and positive diagnostic yield among screened positive participants

	Screen positive Total		Screen positive with CXR CAD score < 0.5*		Screen positive with CXR CAD score ≥ 0.5**		p- value
	N = 752		N = 450		N = 302		
	n/N	%	n/N	%	n/N	%	
Screening by Togue swab							
Tongue swab collected	684/752	90.9%	395/450	88.8%	289/302	95.7%	< 0.001
Tongue swab valid results	606/684	88.5%	343/395	86.8%	263/289	91.0%	0.09
Tongue swab positive	19/606	2.3%	5/343	1.5%	14/263	5.3%	0.007
Sputum specimen collection cascade							
Declined specimen collection	68/752	9.1%	55/450	12.4%	13/302	4.3%	< 0.001
At least one sputum specimen submitted	302/684	44.2%	114/395	28.2%	188/289	65.1%	< 0.001
1st sputum specimen of optimal quantity for Xpert Ultra and sputum swab	243/302	80.9%	100/114	89.1%	143/188	76.5%	0.016
2nd sputum specimen collected for AFB smear and culture	167/243	68.5%	54/100	54.0%	113/143	79.0%	< 0.001
Valid test result among tested							
Sputum swab	243/243	100.0%	100/100	100.0%	143/143	100.0%	
Xpert ultra results	240/243	98.8%	99/100	99.0%	141/143	98.6%	0.782
AFB smear	167/167	100.0%	54/54	100.0%	113/113	100.0%	
TB culture	152/167	90.9%	52/54	96.3%	100/113	88.5%	0.10
Positive test results among valid results							
Sputum swab	16/243	6.6%	0/100	0.0%	16/143	11.2%	0.001

	Screen positive Total		Screen positive with CXR CAD score < 0.5*		Screen positive with CXR CAD score ≥ 0.5**		p- value
	N = 752		N = 450		N = 302		
Xpert Ultra	22/240	9.2%	0/99	0.0%	22/141	15.6%	< 0.001
AFB smear	3/167	1.8%	0/54	0.0%	3/113	2.7%	0.236
TB culture	19/152	12.5%	1/52	1.9%	18/100	18.0%	0.004
TB confirmed by MRS	30/242	12.5%	1/99	1.0%	29/143	20.3%	< 0.001

***Include 445 participants with symptoms and 5 TS positive only participants**

****include 77 with symptoms**

CXR, chest X-ray; TB, tuberculosis; MRS, Microbiological Reference Standard;

Numerator and denominator values are presented as n/N. Percentages (%) in the specimen collection section are calculated using the preceding step in the diagnostic cascade as the denominator.

Sputum valid test results and MTB detection

Among screened positive participants who provided quality sputum, valid results were obtained for 100% (243/243) of sputum swabs, 98.8% (240/243) of Xpert Ultra tests, 100% (167/167) of AFB smears, and 90.9% (152/167) of mycobacterial cultures. MTB was detected in 6.6% (16/243) of sputum swabs, 9.2% (22/240) of Xpert Ultra, 12.5% (19/152) of culture, and 1.8% (3/167) of AFB smear microscopy (Table 2).

Confirmed TB cases

Among 752 screen-positive participants, at least one valid Xpert Ultra and/or mycobacterial culture result was available for 242 individuals for MRS classification, including 240 with valid Xpert Ultra results and 152 with valid culture results (Additional file-1, Table S4).

Using the MRS, TB was confirmed in 30 participants. Of these, 11 were positive by both culture and Xpert MTB/RIF Ultra, 11 by Xpert Ultra alone (6 culture-negative and 5 without culture results), and 8 by culture alone. Among the 22 Xpert Ultra-positive cases, only two had a high bacillary load (one high and one

medium), while others had lower semiquantitative results (8 low, 2 very low, and 10 trace call positive) (Additional file-1, Table S4).

TB was confirmed in 13 of 19 participants screened positive by TS, only one of the remaining six was also screened positive by CXR and W4SS but lacked microbiologically confirmation because sputum could not be collected. The other five participants were negative by both CXR and W4SS; two had negative MRS results, while three could not be evaluated by MRS because sputum was unavailable. (Figure-1)

Among the 30 microbiologically confirmed TB cases, 7 (23.3%) were female, including the only adolescent diagnosed with TB, and 8 (26.7%) were aged ≥ 65 years. Overall, 96.7% (29/30) had abnormal CXR findings, 46.7% (14/30) reported TB symptoms, and 46.4% (13/28) had a positive TS result (Figure-1). Among the 29 TB cases with abnormal CXR findings, 19 (65%) had a CAD score > 0.8 . All symptomatic TB cases reported cough, and 13 of 14 (92.9%) had two or more symptoms. Compared with participants identified through symptoms alone, those identified by abnormal CXR alone (aOR 20.0, 95% CI 2.6–156.4; $p = 0.004$) or by both symptoms and abnormal CXR (aOR 61.5, 95% CI 7.3–517.5; $p < 0.001$) had significantly higher odds of microbiologically confirmed TB. Age and sex were not associated with TB confirmation (Additional file-1, Table S5).

All individuals diagnosed with TB by Xpert MTB/RIF Ultra were clinically evaluated, linked to TB care, and initiated on treatment in accordance with national TB guidelines. Individuals diagnosed by mycobacterial culture were traced after culture results became available and were subsequently linked to TB care and treatment.

Performance of screening tools:

Among 242 screen-positive participants with valid MRS results, 225 had complete results for all three screening tests, including 28 with confirmed TB (Table-3). CXR with a CAD score > 0.5 demonstrated the highest sensitivity (96.7%, 95% CI 82.8–99.9), substantially exceeding that of the W4SS (46.7%, 95% CI 28.3–65.7) and TS testing (46.4%, 95% CI 27.5–66.1). TS testing had the highest specificity (99.0%, 95% CI 96.4–99.9), compared with 46.2% for CXR and 42.0% for the W4SS. Increasing the CXR threshold to > 0.6 improved specificity but reduced sensitivity. Restricting symptom screening to cough lasting > 2 weeks did not improve sensitivity and resulted in only a modest, non-significant increase in specificity compared with the W4SS.

The PPV was highest for TS testing (86.7%, 95% CI 59.5–98.3), whereas CXR had the highest NPV (99.0%, 95% CI 94.5–100)

Table 3
Accuracy of screening tools against microbiological reference standard (MRS)

Screening tool (index test)		Sensitivity n/N, % (95% CI)	Specificity n/N, % (95% CI)	PPV n/N, % (95% CI)	NPV n/N, % (95% CI)
Symptoms (n = 242)	Any symptom of W4SS	14/30	89/212	14/137	89/105
		46.7%	42.0%	10.2%	84.8%
		(28.3–65.7)	(35.3–48.9)	(5.7–16.6)	(76.4–91.0)
	Cough ≥ 2 weeks	14/30	98/114	14/128	98/114
		46.7%	46.2%	10.9%	86.0%
		(28.3–65.7)	(39.4–53.2)	(6.1–17.7)	(78.2–91.8)
	Cough plus at least one other symptom	13/30	132/212	13/93	132/149
		43.3%	62.3%	14.0%	88.6%
		(25.5–62.6)	55.4–68.8	7.7–22.7	82.4–93.2
Chest X-Ray (n = 242)	CAD score > 0.5	29/30	98/212	29/143	98/99
		96.7%	46.2%	20.3%	99.0%
		(82.8–99.9)	(39.4–53.2)	(14.0–27.8)	(94.5–100)
	CAD score > 0.6	23/30	119/212	23/116	119/126
		76.7%	56.1%	19.8%	94.4%
		(57.7–90.1)	(49.2–62.9)	(13.0–28.3)	(88.9–97.7)
Tongue swab Minidock MTB (n = 225)	All	13/28	195/197	13/15	195/210
		46.4%	99.0%	86.7%	92.9%
		(27.5–66.1)	(96.4–99.9)	(59.5–98.3)	(88.5–95.9)

n, numerator; *N*, denominator; *PPV*, positive predictive value; *NPV*, negative predictive value;

Performance of TS, CXR, and W4SS against the MRS based on combined screening results is shown in Additional file-1, Table S6. An overlap of screened positive and TB case detection by CXR, W4SS and TS among 225 cases with all three screening results is shown in additional file-1, Figure-S2

Number needed to screen and test to detect one TB case and prevalence of undiagnosed TB

The NNS to find one TB case was lowest for CXR (148) and highest for W4SS (307), with an NNS of 264 for TS. The NNT was lowest for TS (1.2) and highest for W4SS-positive participants (9.8). The estimated prevalence of undiagnosed TB in the community was 325, 379, and 674 cases per 100,000 screened participants based on W4SS, TS, and CXR, respectively, with little difference when other screening modalities were combined with CXR. (Table-4)

Table 4
Number needed to screen (NNS) to find one TB cases and estimated prevalence of undiagnosed TB cases by screening modalities

a. Number of participants	W4SS	CXR	NPOC	W4SS+ CXR	W4SS + CXR+NPOC	
	4303	4303	4303	4303	4303	
b. Number with screening results	4303 (100%)	4303 (100%)	3432 (79.8%)	4303 (100%)	4303* (100%)	3432** (79.8%)
c. Number screen positive	522 (12.1%)	302 (7.1%)	19 (0.55%)	747 (17.4%)	752 (17.5%)	606 (17.7%)
d. Number with MRS results	137 (26.2%)	143 (47.4%)	15 (78.9%)	240 (32.1%)	242 (32.2%)	225 (37.1%)
e. Number confirmed TB	14	29	13	30	30	28
f. Number needed to screen (NNS) to find one TB (b/e)	307	148	264	143	143	123
g. Number needed to test (NNT) to detect one TB case (d/e)	9.8	4.9	1.2	8.0	8.1	8.0
h. Estimated prevalence of undiagnosed TB cases /100,000 population. (e/b*100000)	325 (178–545)	674 (452–966)	379 (202–647)	697 (470–993)	697 (470–993)	816 (542–1176)
*Includes all screened participants.						
** Includes only participants with valid results for all three screening modalities.						

Discussion

To our knowledge, this is the first study to evaluate use of MiniDock MTB entirely in a community based ACF setting and the first to assess its performance as a screening tool. TS testing using the MiniDock MTB platform demonstrated high specificity (99.0%) and PPV(86.7%) but low sensitivity (46.4%). In

contrast, CXR achieved the highest sensitivity (96.7%) and identified all confirmed TB cases, whereas less than half of all TB cases had TB symptoms .

Studies have consistently shown that symptom screening has poor performance and limited value as a stand-alone tool for TB screening in community settings (13). In contrast, CAD-enabled CXR has substantially improved the detection of microbiologically confirmed TB, particularly among individuals with subclinical or minimally symptomatic disease (13, 25–27). In our study, 29 of 30 (96.7%) microbiologically confirmed TB cases had CXR abnormalities interpreted by CAD as suggestive of TB, and only half (14/30) had symptoms, whereas only one case was identified through symptoms alone. Consistent with modelling studies and TB prevalence surveys, our findings demonstrate that screening algorithms incorporating CXR achieve substantially higher case detection than symptom-based approaches, particularly in populations with a high burden of asymptomatic disease (28).

Although ultra-portable CXR interpreted using qXR demonstrated excellent sensitivity (96.7%), specificity (46.2%) was lower than that reported in multicountry CAD evaluation studies conducted in clinical settings (29, 30). However findings were consistent with pooled results from five community-based ACF studies in South Africa (31). This suggests that the lower specificity observed in our study may reflect the realities of community-based screening rather than limitations of the CAD approach itself. Higher specificities can be reached by raising the threshold score, but at the cost of sensitivity. The presence of non-tuberculous pulmonary abnormalities or paucibacillary TB not detected by the reference standard could also lower specificity. Nevertheless, CXR maintained an excellent negative predictive value and identified nearly all confirmed TB cases, supporting its role as a highly sensitive screening tool for community-based ACF.

WHO strongly recommends systematic testing with mWRDs for TB among inpatients with HIV (32–35). However evidence supporting mWRD-based screening in the general population remains uncertain and is considered indirect, as most studies have been conducted in selected high-risk populations, such as prisoners(36), household contacts(4, 37) and miners(38), with substantial variation in sensitivity across studies. Recognising challenges related to access, cost, and operational feasibility, WHO conditionally recommends mWRDs as an option for TB screening in other population groups.

Low-cost NPOC tests are emerging as promising tools for TB diagnosis using non-sputum specimens, particularly in settings where sputum collection is challenging (15). Early studies which evaluated diagnostic accuracy of MiniDock MTB on TS specimens reported sensitivities of approximately 70–80% against MRS (17, 19, 21), with high participant acceptability and ease of specimen collection (18, 39), raising interest in use of the assay on TS as a simple, inexpensive screening tool. We evaluated screening performance of MiniDock MTB in a community-based screening setting and found much lower sensitivity with minimal incremental value of TS screening over W4SS and CXR. The lower sensitivity is likely explained by differences in study setting and disease spectrum(40–42). Previous studies were largely conducted in clinical settings among symptomatic individuals and reported a higher tongue and sputum swab sensitivity specially among smear-positive individuals and those with higher bacillary

burden(41, 42). In contrast, in our study conducted in general population under community based ACF conditions, among TB cases detected, only 10% were AFB smear positive or had a high bacillary burden. However our findings are consistent with lower sensitivity reported by the only published study that included participants recruited partly through community-based screening, likely reflecting the low bacillary burden of TB detected through ACF (21). Thus, TS performance should be interpreted in the context of community-based screening, where TB cases are detected earlier and are predominantly paucibacillary. However, performance could differ in underserved communities with limited healthcare access, where barriers to care result in delays in diagnosis and a higher proportion of people with undiagnosed advanced TB disease. Updated versions of the MiniDock cartridge may be able to address this shortcoming.

In our study, approximately 20% of participants did not have valid TS results due to specimen refusal or invalid results. Thus, valid TS results were available for only about 80% of participants, compared with symptom and CXR screening results for all participants. The invalid TS rate in our study (10.4%) was considerably higher than the approximately 1% reported in previous accuracy studies (17, 19, 21), including our earlier facility-based diagnostic accuracy study in Pakistan(43). However, in the current study, no invalid results were observed for sputum swabs tested on the MiniDock platform, suggesting that factors related to TS specimens, rather than the assay itself, may have contributed to test failures. Invalid TS results were more common among females and adults aged ≥ 20 years than among adolescents, although these differences may reflect unmeasured behavioural factors. The widespread use of paan, betel nut, and other smokeless tobacco products in South Asian communities (23, 44), which was commonly observed among study participants, may have affected specimen quality or assay performance. As these exposures were not systematically assessed, their contribution to invalid TS results warrants further investigation. The high invalid rate observed in our setting may therefore not be generalisable to populations where these practices are less common, but should be considered and monitored when implementing TS-based testing.

We documented a high level of sputum scarcity, exceeding that reported among people living with HIV (12), particularly among presumptive TB participants identified based on symptoms alone. Similar findings have been reported in community-based ACF study from Nigeria where only 11.6% of symptom positive presumptive TB participants were able to provide sputum (24) and our previous study among returnee coal miners and their associated communities, where 35% of presumptive TB participants in the associated communities were unable to produce sputum(45). Consistent with the Nigeria ACF study, we also documented a higher sputum collection rate among individuals with abnormal CXR. These findings suggest that sputum scarcity is an important operational challenge for community-based TB screening, particularly in populations with potentially early or paucibacillary disease, while also suggesting that participants unable to produce sputum may be less likely to yield additional TB diagnoses. A non-sputum test could therefore offer an important advantage for sputum scarce individuals (46), although we did not see the same benefit in our community-based ACF setting. One possible explanation is that, individuals who cannot produce spuutm during community based ACF are more likely to have lower bacillary loads, and less likely to test positive on oral swabs.

The NNS observed in our study was generally lower than the mean estimates reported in the WHO systematic review (CXR: 148 vs 1,492; W4SS: 307 vs 964; and CXR+W4SS: 143 vs 165)(6). The relatively high TB yield observed with CXR, reflected by the lower NNS and higher estimated prevalence of undiagnosed TB, highlights the potential value of CXR-based screening. In contrast, the lower yield of symptom-based screening highlights its limited ability to identify undiagnosed TB in the general population, may often be asymptomatic. The high specificity and low NNT of TS suggest potential value as a targeted diagnostic or triage tool, although its limited sensitivity constrains its use as a standalone screening test. Although the WHO TPP recognizes that simple, highly specific tests with moderate sensitivity may have value when they are easy to implement and scalable(8). The operational advantages of TS, including ease of specimen collection, simplicity of testing, and lower cost, may be relevant in settings where this level of sensitivity can still provide meaningful benefit for TB case finding.

A major strength of this study is the prospective evaluation of multiple screening tools under routine, community-based ACF setting, generating real-world evidence on its uptake, feasibility, operational performance as screening tool. The study has several limitations. The small number of microbiologically confirmed TB cases (n = 30) resulted in wide confidence intervals around the test accuracy estimates. The high proportion of sputum-scarce individuals limited the availability of the MRS. Screening performance was evaluated only among screen-positive participants, and not all participants had culture results. Finally, the study was conducted in a single country, which may limit the generalizability of the findings.

Conclusion

TS testing was feasible for community-based implementation and offered the operational advantage of a non-sputum specimen. However, participant refusal, invalid results, and limited sensitivity reduced its effectiveness in this community-based ACF setting. TS was not sufficiently sensitive to function as a stand-alone screening test and did not identify additional TB cases among individuals negative by other screening methods or those unable to provide sputum. Further optimization of specimen collection and assay performance, together with evaluation in populations with different disease spectra and bacillary burdens, is needed to better define the role of TS testing in community-based TB screening.

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Abbreviations

ACF
Active case finding
CAD

Computer aided diagnosis
CXR
Chest X-ray
MRS
Microbiological Reference standard
NNS
Number needed to screen
NNT
Number needed to test
NPOC
Near point of care
PTRL
Provincial TB reference laboratory
TB
Tuberculosis
TPP
Target Product Profile
TS
Tongue swab
W4SS
WHO recommended symptom screening
WHO
World Health organization

Declarations

Author Contribution

K.E. contributed to the conceptualization and design of the study, overall scientific oversight and supervision, data acquisition and analysis and interpretation of the findings, and critical review and revision of the manuscript. Y.L.J. critically reviewed and substantively revised the manuscript and contributed to the interpretation of the findings. S.Q. contributed significantly to the acquisition of data and reviewed the manuscript. U.L. contributed to the acquisition of data and reviewed the manuscript. B.K. contributed to the conceptualization and design of the study and critically reviewed the manuscript. J.C. contributed to the conceptualization and design of the study, data analysis and interpretation, and substantially revised the initial draft of the manuscript. S.T. made a major contribution to the study design and methodology, data analysis and interpretation, drafted the original manuscript, and led its substantive scientific revision and refinement. All authors read and approved the final manuscript.

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Data Availability

All data supporting the findings of this study are available within the paper and its Supplementary Information.

References

1. World Health Organization. Global tuberculosis report 2025. 2025.
2. Dowdy DW, Basu S, Andrews JR. Is passive diagnosis enough? The impact of subclinical disease on diagnostic strategies for tuberculosis. *Am J Respir Crit Care Med*. 2013;187(5):543 – 51.
3. Golub JE, Mohan CI, Comstock GW, Chaisson RE. Active case finding of tuberculosis: historical perspective and future prospects. *Int J Tuberc Lung Dis*. 2005;9(11):1183 – 203.
4. Yuen CM, Amanullah F, Dharmadhikari A, Nardell EA, Seddon JA, Vasilyeva I, et al. Turning off the tap: stopping tuberculosis transmission through active case-finding and prompt effective treatment. *Lancet*. 2015;386(10010):2334-43.
5. World Health Organization. Implementing the End TB Strategy: The Essentials. Geneva 2015.
6. World Health Organization. WHO consolidated guidelines on tuberculosis: module 2: screening: systematic screening for tuberculosis disease. Geneva, Switzerland World Health Organization; 2021.
7. MacPherson P, Shanaube K, Phiri MD, Rickman HM, Horton KC, Feasey HRA, et al. Community-based active-case finding for tuberculosis: navigating a complex minefield. *BMC Global and Public Health*. 2024;2(1):9.
8. World Health Organization. Target product profiles for tuberculosis screening tests. Geneva; 2025.
9. 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(9):1128-45.
10. World Health Organization. National tuberculosis prevalence surveys 2007–2016. 2021 3 May 2021 Report No.: ISBN: 978-92-4-002243-0.

11. Garg T, John S, Abdulkarim S, Ahmed AD, Kirubi B, Rahman MT, et al. Implementation costs and cost-effectiveness of ultraportable chest X-ray with artificial intelligence in active case finding for tuberculosis in Nigeria. *PLOS Digit Health*. 2025;4(6):e0000894.
12. Gaeddert M, Papadopoulou P, Habbes J, Niederegger T, Schik L, Meister J, et al. Sputum scarcity among adolescents and adults with presumptive tuberculosis: a systematic review and meta-analysis. *medRxiv*. 2025.
13. Frascella B, Richards AS, Sossen B, Emery JC, Odone A, Law I, et al. Subclinical Tuberculosis Disease- A Review and Analysis of Prevalence Surveys to Inform Definitions, Burden, Associations, and Screening Methodology. *Clin Infect Dis*. 2021;73(3):e830-e41.
14. Vachaspathi TD. Tuberculosis Diagnostics Pipeline Report 2025. Treatment Action Group; 2025 November 2025.
15. Church EC, Steingart KR, Cangelosi GA, Ruhwald M, Kohli M, Shapiro AE. Oral swabs with a rapid molecular diagnostic test for pulmonary tuberculosis in adults and children: a systematic review. *The Lancet Global Health*. 2024;12(1):e45-e54.
16. World Health Organization. Near point-of-care tests, tongue swabs, and sputum pooling for TB Geneva, Switzerland 2026 [
17. Mbuli C, Jean Bosco TF, Nsamenang R, Nestor B, Nguimfack G, Mbuh NN, et al. Diagnostic performance of the Pluslife MiniDock MTB and Molbio MTB Ultima assays to detect tuberculosis from tongue and sputum swabs among outpatients and in active case finding in Cameroon. *Clin Infect Dis*. 2025.
18. Moe CA, Luswata RK, Barrameda AJ, Le H, Muzazu S, Crowder R, et al. Diagnostic Yield of Tongue Swab- Compared to Sputum-Based Molecular Testing for Tuberculosis in Four High-Burden Countries. *Clinical Infectious Diseases*. 2026.
19. Steadman A, Kumar KM, Asege L, Kato-Maeda M, Mukwatamundu J, Shah K, et al. Diagnostic accuracy of swab-based molecular tests for tuberculosis using near-point-of-care platforms: a multi-country evaluation. *EBioMedicine*. 2025;121:105991.
20. Wu Z, Yan L, Lai X, Yang J, Liang J, Ma X, et al. Diagnostic accuracy of a novel point-of-care tongue swab assay for pulmonary tuberculosis: a multicentre prospective study. *Clinical Microbiology and Infection*. 2026;32(2):331-6.
21. Yerlikaya S, Chirwa M, Ajide B, Castro MdM, Ha H, Kato-Maeda M, et al. Pulmonary Tuberculosis Detection with MiniDock MTB Using Swab Samples. *New England Journal of Medicine*. 2026;394(17):1710-22.

22. Pakistan Bureau of Statistics. 7th Population and Housing Census 2023: Table 1—Area, population by sex, sex ratio, population density, urban proportion, household size and annual growth rate, Sindh—District Wise. Pakistan Bureau of Statistics;; 2023.
23. Banerjee SC, Ostroff JS, Bari S, D'Agostino TA, Khera M, Acharya S, et al. Gutka and Tambaku Paan use among South Asian immigrants: a focus group study. *J Immigr Minor Health*. 2014;16(3):531-9.
24. John S, Abdulkarim S, Usman S, Rahman MT, Creswell J. Comparing tuberculosis symptom screening to chest X-ray with artificial intelligence in an active case finding campaign in Northeast Nigeria. *BMC Glob Public Health*. 2023;1(1):17.
25. Cotugno S, Guido G, Di Gennaro F, Cavallin F, Pisaturo M, Onorato L, et al. Symptomatic (STB) and Asymptomatic (ATB) tuberculosis in Italy: Results from a multicenter retrospective study. *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*. 2025;41:100556.
26. Coussens AK, Zaidi SMA, Allwood BW, Dewan PK, Gray G, Kohli M, et al. Classification of early tuberculosis states to guide research for improved care and prevention: an international Delphi consensus exercise. *Lancet Respir Med*. 2024;12(6):484 – 98.
27. van't Hoog AH, Meme HK, Laserson KF, Agaya JA, Muchiri BG, Githui WA, et al. Screening strategies for tuberculosis prevalence surveys: the value of chest radiography and symptoms. *PLoS One*. 2012;7(7):e38691.
28. van't Hoog AH, Onozaki I, Lonnroth K. Choosing algorithms for TB screening: a modelling study to compare yield, predictive value and diagnostic burden. *BMC Infectious Diseases*. 2014;14(1):532.
29. Worodria W, Castro R, Kik SV, Dalay V, Derendinger B, Festo C, et al. A multi-country head-to-head accuracy comparison of automated chest X-ray algorithms for tuberculosis. *Annals of the American Thoracic Society*. 2026;23(5):728 – 36.
30. Gelaw SM, Kik SV, Ruhwald M, Ongarello S, Egzertegegne TS, Gorbacheva O, et al. Diagnostic accuracy of three computer-aided detection systems for detecting pulmonary tuberculosis on chest radiography when used for screening: Analysis of an international, multicenter migrants screening study. *PLOS Glob Public Health*. 2023;3(7):e0000402.
31. Scott AJ, Perumal T, Pooran A, Oelofse S, Jaumdally S, Swanepoel J, et al. Clinical evaluation of computer-aided digital x-ray detection of pulmonary tuberculosis during community-based screening or active case-finding: a case-control study. *Lancet Glob Health*. 2025;13(3):e517-e27.
32. Thit SS, Aung NM, Htet ZW, Boyd MA, Saw HA, Anstey NM, et al. The clinical utility of the urine-based lateral flow lipoarabinomannan assay in HIV-infected adults in Myanmar: an observational study. *BMC Med*. 2017;15(1):145.

33. Lawn SD, Kerkhoff AD, Burton R, Schutz C, van Wyk G, Vogt M, et al. Rapid microbiological screening for tuberculosis in HIV-positive patients on the first day of acute hospital admission by systematic testing of urine samples using Xpert MTB/RIF: a prospective cohort in South Africa. *BMC Med*. 2015;13:192.
34. Heidebrecht CL, Podewils LJ, Pym AS, Cohen T, Mthiyane T, Wilson D. Assessing the utility of Xpert(®) MTB/RIF as a screening tool for patients admitted to medical wards in South Africa. *Sci Rep*. 2016;6:19391.
35. Bjerrum S, Kenu E, Lartey M, Newman MJ, Addo KK, Andersen AB, et al. Diagnostic accuracy of the rapid urine lipoarabinomannan test for pulmonary tuberculosis among HIV-infected adults in Ghana- findings from the DETECT HIV-TB study. *BMC Infect Dis*. 2015;15:407.
36. Al-Darraj HA, Abd Razak H, Ng KP, Altice FL, Kamarulzaman A. The diagnostic performance of a single GeneXpert MTB/RIF assay in an intensified tuberculosis case finding survey among HIV-infected prisoners in Malaysia. *PLoS One*. 2013;8(9):e73717.
37. Beyanga M, Kidenya BR, Gerwing-Adima L, Ochodo E, Mshana SE, Kasang C. Investigation of household contacts of pulmonary tuberculosis patients increases case detection in Mwanza City, Tanzania. *BMC Infect Dis*. 2018;18(1):110.
38. Dorman SE, Chihota VN, Lewis JJ, Shah M, Clark D, Grant AD, et al. Performance characteristics of the Cepheid Xpert MTB/RIF test in a tuberculosis prevalence survey. *PLoS One*. 2012;7(8):e43307.
39. Codsì R, Saluzzo F, Wood RC, Olson AM, Russo G, Ragazzoni L, et al. Acceptability of tongue swabs for tuberculosis screening in migrant settings in northern Italy: A qualitative study. *PLOS Glob Public Health*. 2026;6(3):e0004908.
40. Zaidi S, Garg T, Quang Vo LN, Sander M, Codlin AJ, Byrne RL, et al. How can spectrum bias impact expectations of test performance: a secondary modeling study estimating novel swab-based test outcomes across populations. *medRxiv*. 2026:2026.07.02.26357020.
41. Chani K, Athallah MA, Colquhoun S, Tsheten T, Huang GK, Chirenda J, et al. Proportions of Xpert MTB/RIF Ultra 'trace' results vary widely among different populations with presumptive TB. *Int J Tuberc Lung Dis*. 2025;29(6):271-7.
42. Van Dinh L, Tran KT, Codlin AJ, Vo LNQ, Nguyen NTT, Nguyen LP, et al. Prevalence of Xpert MTB/RIF Ultra Trace Call Results and Associated Risk Factors During Active Tuberculosis Case Finding in Viet Nam: A Programmatic Evaluation. *Diagnostics*. 2025;15(8):1006.
43. Eman KU, Jackson YL, Lodhi UR, Kirubi B, Qureshi S, Creswell J, et al. Performance of swab-based MiniDock MTB test for the diagnosis of pulmonary TB. *IJTL Open*. 2026;3(9):604-6.

44. Niaz K, Maqbool F, Khan F, Bahadar H, Ismail Hassan F, Abdollahi M. Smokeless tobacco (paan and gutkha) consumption, prevalence, and contribution to oral cancer. *Epidemiol Health*. 2017;39:e2017009.
45. Eman KU, Kazi GN, Lodhi UR, Kirubi B, Ali M, Shahzad M, et al. Active TB case finding in returnee coalminers and their home district communities in Pakistan. *Public Health Action*. 2025;15(4):173-8.
46. Rockman L, Abdulgader S, Minnies S, Naidoo D, Chiwaya A, Nwamba W, et al. Diagnostic accuracy of Pluslife MiniDock MTB on tongue swabs in sputum scarce people with presumptive TB: a retrospective analysis. *Res Sq*. 2026.

Figures

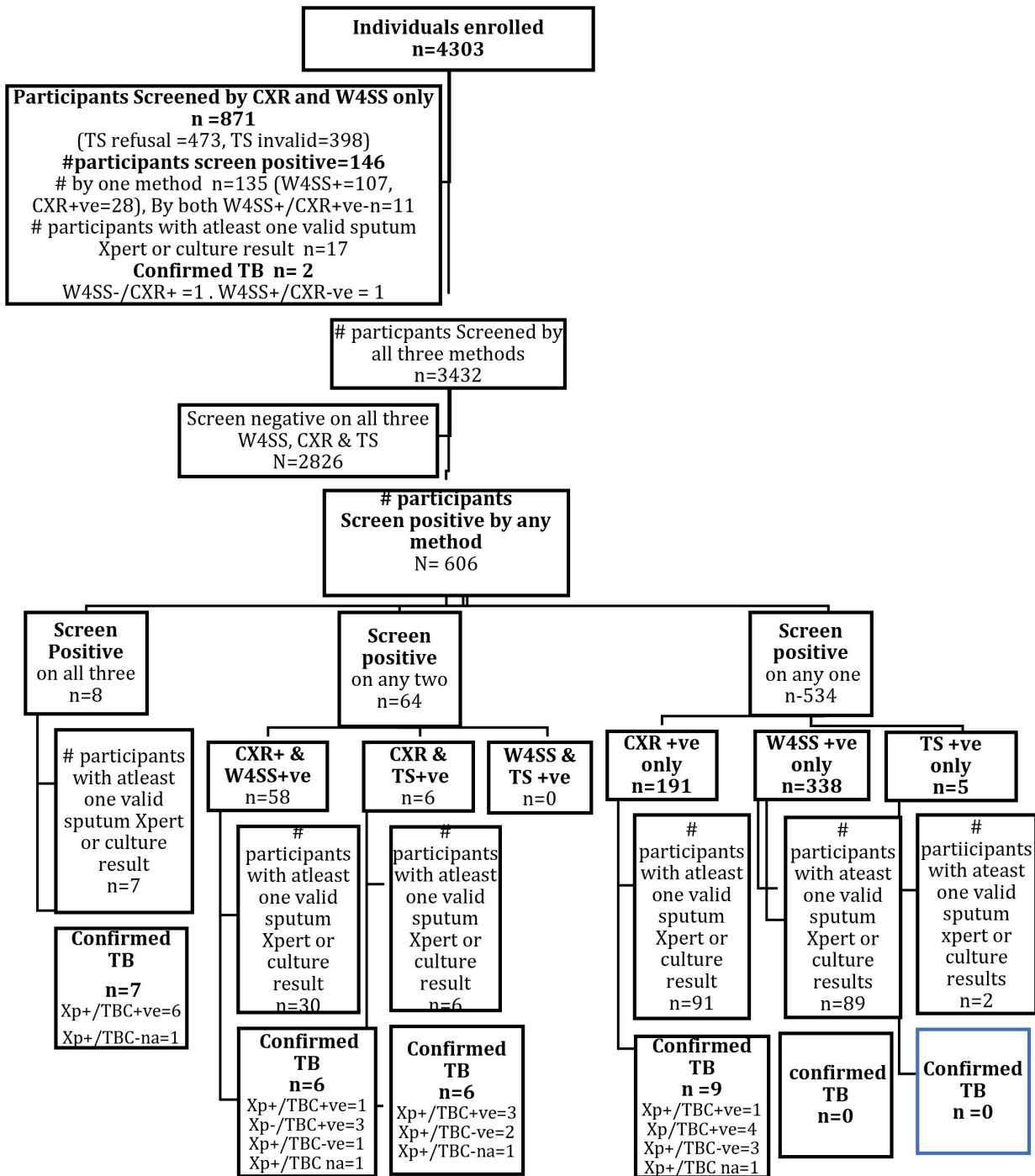


Figure 1

Participant flow through chest X-ray, WHO four-symptom, and MiniDock MTB tongue swab screening, screened positive groups and MRS results in community-based active TB case finding.

Supplementary Files

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