BMC Public Health

RESEARCH

Open Access

Engaging private providers to enhance tuberculosis detection and notification: evidence from TB REACH-Supported projects

Md. Toufiq Rahman[1*†], William A. Wells[2†], Oriol Ramis[3], Vishnu V. Kamineni[4], Mirjam I. Bakker[5], Sode Matiku[6], Miranda Brouwer[7] and Jacob Creswell[1]

Abstract

Background Private providers (PPs), rather than public facilities, are often the first point of contact in the health system for people with tuberculosis (TB). However, PP's potential for enhancing TB detection remains underutilized.

Methods TB REACH is an initiative of Stop TB Partnership focused on improving TB detection and notification. We analyzed the results of interventions using private provider engagement (PPE) to impact TB detection and notification across four TB REACH funding waves from May 2018 through March 2022.

Results Overall, 35 projects documented screening of 13,038,586 people for TB, referral of 384,364 (3% of those screened) for diagnostic testing, and testing of 332,266 (86%) people. In total, 64,456 all forms of TB were diagnosed, and 62,830 (97% of those diagnosed) were linked to treatment. To diagnose one person with TB, the overall number needed to screen and test was, respectively, 281 (range across projects: 2–8,705) and 7 (range across projects: 1–24). Twenty-five projects mapped 69,187 PPs, both formal and informal, and engaged 21,206 (31%) providers during the intervention period, 12,211 (58%) of whom actively referred at least one person with TB symptoms during the intervention period. During the implementation period, TB notifications in the intervention areas increased by 25% ($n=61,123$; from 246,845 to 307,968), with 20% of the total TB notifications attributed to the PPE projects. The mean and median cost per person started on treatment through the PPE projects was USD 221 and USD 481 (range across projects: 23 – 8,689).

Conclusions Our findings suggest that structured and targeted PPE enhances TB case finding and contribute in closing the gap of missing cases. These results emphasize the need for wider implementation and scale-up of PPE in the TB response.

Keywords Tuberculosis, Private providers, TB REACH, TB detection, Notification, Engagement strategies

†Md. Toufiq Rahman and William A Wells contributed equally to this work.

*Correspondence:
Md. Toufiq Rahman
toufiqr@stoptb.org
[1]Innovations & Grants Team, Stop TB Partnership, Geneva, Switzerland
[2]United States Agency for International Development, Washington, D. C, USA
[3]Independent consultant, Barcelona, Spain
[4]Independent consultant, Bangalore, India
[5]KIT Royal Tropical Institute, Global Health, Amsterdam, The Netherlands
[6]New Dimension Consulting (T), Dar es Salaam, Tanzania
[7]PHTB Consult, Haren, The Netherlands

Background

Tuberculosis (TB) remains a major global health problem, with an estimated 10.6 million people developing the disease in 2022, yet al.most 30% of people with TB are not notified to national TB programs (NTPs) [1]. While the public sector has traditionally been at the center of the TB response, it is the private sector that often serves as the first point of contact for individuals seeking healthcare, particularly in high TB burden countries where the public sector may be under-resourced, stigmatizing or difficult to access. Many people with TB who are not notified to TB programs are therefore presumed to be diagnosed and treated in the private sector [2–5]. Indeed, studies using private drug sales in several countries have documented large numbers of people purchasing TB drugs for treatment, most of whom do not get reported to national authorities [6, 7]. In response, private provider engagement (PPE)– mapping private providers, and assisting them to provide quality TB care and notify these patients– has increasingly been recognized as a vital component of national TB responses [2–5], and a critical way to improve not only TB case detection rates but also quality metrics such as treatment outcomes [5, 8].

Implementers seeking to design PPE approaches will benefit from robust data, including data on expected yield, additionality, cost implications, and the identification of engagement approaches with higher or lower yields. Numerous TB PPE projects have been implemented across different regions, yielding useful data on referrals, detection [2, 9–13], treatment outcomes [14, 15], and costing [16, 17]. Increasingly, TB PPE efforts have progressively transitioned from being pilot approaches to national scale-up [18, 19], enhancing private sector notification and contributing to reducing the gap of missed people with TB in several high TB burden countries [1, 20–22]. Most of these efforts reported only the total detection and treatment outcomes, without further information on diagnostic cascades or locations of initial care seeking. More recent PPE approaches have evaluated the engagement and coverage of specific types of PPs, which can be helpful in documenting how different providers can contribute to improving TB care [23–25]. However, data from more recent PPE approaches has been limited to individual studies without larger reviews.

Starting in 2018, the United States Agency for International Development (USAID) provided support to fund interventions specifically focused on PPE through the TB REACH initiative. This eventually included 35 different projects that were implemented across four different funding waves using a variety of approaches across many geographical settings. The grants were framed by technical guidance [26] and a tailored monitoring and evaluation (M&E) framework for PPE. Here, we report on the results from those projects to assess the impact of PPE on TB case notification and to draw lessons from these interventions.

Methods

Overview of TB REACH and support for private provider engagement

TB REACH is an initiative of the Stop TB Partnership that has been focused on improving TB detection through a variety of approaches, including active case finding, implementing new diagnostics, childhood TB interventions, and PPE [27]. TB REACH offers grants to innovators through a competitive application processes (with a grant award rate of ~3–7%), enabling the development and application of novel strategies and technologies to identify and treat people suffering from TB, drug-resistant TB, and TB infection. The projects revolve around healthcare delivery, not research, but are subject to rigorous M&E. New approaches that show promise under TB REACH are targeted for scale-up under other funding sources.

In 2017, the World Health Organization (WHO) and USAID supported a process by which multiple high TB burden countries developed action plans for national-level scale-up of TB PPE [18]. One notable barrier to such scale-up was found to be an insufficient number of TB PPE implementers and models in certain high TB burden countries. USAID therefore provided earmarked funding to TB REACH to support new TB PPE implementers and interventions through calls for proposals. These efforts were included in TB REACH funding for Wave 6, Wave 6 Scale-up, Wave 7, and Wave 8 and included a total of 36 PPE projects, 35 of which were implemented and therefore included in this analysis. All of these 35 projects (see project details in Supplementary Table 1) were designed by grantees to enhance TB care through differentiated private sector approaches tailored to their local context.

Data analysis and PPE monitoring and evaluation framework

Data submission

TB REACH worked with USAID to develop a dedicated M&E framework for PPE during Wave 6 to enhance what has been widely used to document interventions focused on improved TB detection [28, 29].

All TB REACH projects reported quarterly through TB REACH's online grant management system (GMS). Projects reported process indicators that document the TB diagnostic cascade and official national TB program (NTP) data (including TB notifications), and also submitted financial reports. Data were aggregated prior to reporting and no personal identifying information was used. In this analysis, we used aggregate quarterly reported data collected through the GMS for the PPE

projects and exported them for analysis, which was conducted using Microsoft Excel and SPSS v29.

In addition to the TB diagnostic cascade routinely documented for TB REACH projects, the PPE M&E framework included additional data specifically around the PPE activities (Fig. 1). Prior to each project, implementers reported historical data on TB notifications overall, and specifically from the private sector, in the defined evaluation area. A control area was defined for each project before activities commenced in consultation with the M&E team to be as comparable as possible to the evaluation areas while minimizing the chance that project activities would impact results in the control areas.

We excluded one Wave 7 TB REACH project from the analysis as it was affected by Covid-19 restrictions and could not initiate case finding activities. A total of 35 projects were included for the basic care cascade metrics including the number screened, numbers of people with presumptive TB identified and evaluated, people with TB diagnosed (project yield), and people notified with TB and enrolled for treatment (PPE notifications) (Fig. 1).

Definition of the data analysis metrics

Project yield was the number of people diagnosed with TB as a direct result of the PPE initiatives. *PPE notifications* were a subset of the yield (those people diagnosed who were successfully notified to the NTP and linked to treatment). We measured the *additional notifications* by comparing the total number of TB notifications (from all types of providers– both public and private– in the defined evaluation area as well as a control area) during the intervention period with those in the corresponding baseline period. For projects lasting 12 months, the baseline period was the 12 months before the project started. For 18-month projects, we adjusted the baseline by multiplying the 12-month baseline by 1.5. This comparison was expressed as a percentage change in notifications. Meanwhile, the *PPE contribution* was determined by taking the number of people with TB notified by the PPE intervention (*PPE notifications)* and dividing by the total TB notifications in the evaluation area during the reporting period. This ratio provides an estimate of the broader impact of PPE interventions on TB detection.

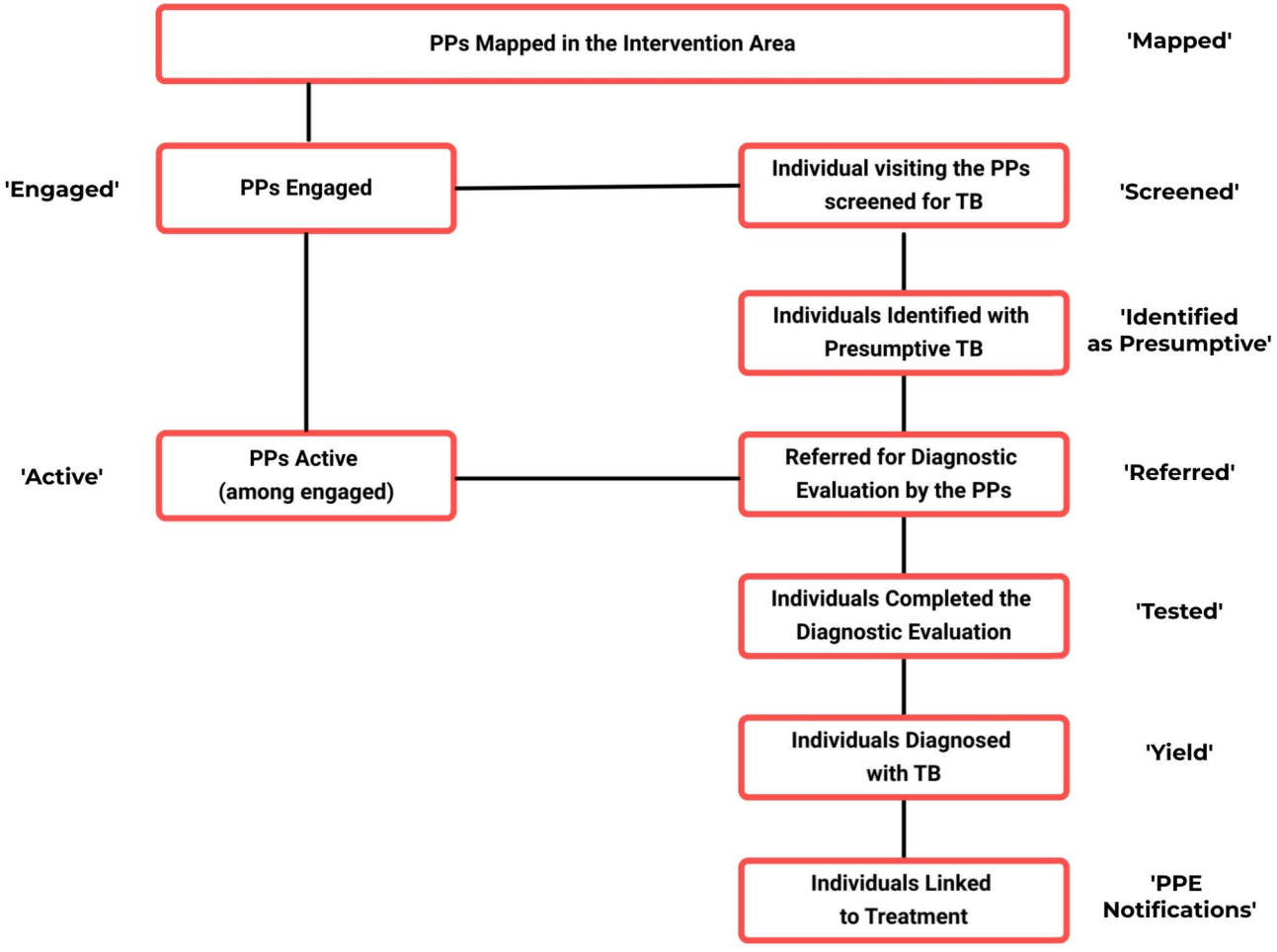

Fig. 1 Process and indicators for TB PPE

From the PPE project data, we also calculated the number needed to screen (NNS) to diagnose one person with TB, the number of people who needed to be tested (NNT) to diagnose one person with TB, and the percentage of those tested who were diagnosed with TB (diagnostic positivity). Three projects did not report screening data and one did not report testing data, so NNS and NNT could be reported for only 32 and 34 projects, respectively.

The cost per person diagnosed and started on treatment was also analyzed for all 35 projects. The project cost was defined as the sum of the project budget for expenditures for staffing (for both field staff and project management), transport allowances (e.g., for sample transport and supervision visits), service fees for completing diagnostic testing, diagnostic commodities unless supplied by NTPs, M&E processes, and overall project administration.

Most data were analyzed on a per-project basis, but certain summary data are reported across the entire portfolio of projects (i.e., by summing all data from all projects), and a selection of data are presented by individual waves since these sub-groups of projects represent a particular period in time (since each wave launched ~ 15 months later than the previous wave). These choices and their rationale are provided alongside the relevant data in the Results section.

Analysis of contributions according to provider type

Implementers mapped the types and numbers of PPs in the intervention area and set targets for the PPs they aimed to engage. From Wave 7 onwards, we tracked the number of engaged and active providers, the referrals made by certain categories of PPs, and the subsequent TB case notifications. This enabled a more comprehensive analysis of the engagement of different PP types, which was conducted using the PPE M&E framework using data from the 25 projects in Wave 7 onwards.

We used the following classifications of PPs for the analysis: informal private providers/facilities (which included traditional healers, herbalists, unqualified medical practitioners, and non-allopathic practitioners); private pharmacies and drug stores; private formal providers (which included general practitioners, and specialists including pulmonologists); private laboratories; and private formal facilities (which included private hospitals and multi-provider clinics). We classified the primary engagement focus of projects by determining the highest number of providers reached and engaged by that individual project. However, analysis of the engagement, activity and referral patterns for various provider types was based not on this project-wide classification but on data from individual providers. We defined an *engaged* PP as a provider with the intention to participate in the project, as demonstrated through their involvement in a training or onboarding activity and/or the signing of a formal memorandum of understanding between the PP and the project. A PP was defined as *active* if they referred at least one person with TB symptoms for testing during a quarterly reporting period.

Results

TB REACH supported 35 PPE projects over four funding waves in 19 countries with USD 13.9 million in project implementation funding. Most projects (57%, $n = 20$) were located in Asia, followed by 40% ($n = 14$) projects in Africa and one in Central Asia (Kyrgyzstan).

Types of PPs engaged

A total of 20 projects (57%) engaged multiple types of PPs while 15 projects (43%) targeted and engaged only one type of PP. The primary focus of PP engagement by the projects was private formal providers (13; 37%), private pharmacies or drug sellers (8; 23%), informal private providers (8; 23%), private formal facilities (5; 14%), and private laboratories (1; 3%).

Diagnostic cascade

The diagnostic cascade is shown in Fig. 2. Overall, the projects documented 13,038,586 people screened for TB, using a variety of screening algorithms. Out of those screened, 384,364 (3%) were referred for diagnosis, and 332,266 (86% of those referred) were tested, 48,757 people (15%) were diagnosed with TB (all forms; out of which 31,144 (64%) had bacteriologically confirmed TB). In total, 64,456 people with all forms of TB were diagnosed (including 15,699 from a pharmacy project that collected data post-diagnosis and therefore did not have testing numbers), and 62,830 (97% of those diagnosed) were notified and linked to treatment. The percentage of those tested who were diagnosed with TB (diagnostic positivity) in Wave 6, Wave 6 Scale-Up, Wave 7 and Wave 8 was 10%, 13%, 15% and 19%, respectively. Almost half of all TB case finding came from Wave 8 alone: Wave 6 contributed 8% of total TB case finding, compared to 15% from Wave 6 Scale-up, 29% from Wave 7, and 49% from Wave 8.

The overall NNS and NNT for the projects was 281 ($n = 32$ projects) and 7 ($n = 34$ projects), respectively (Fig. 2). To analyze variability between projects, we also calculated an NNS and NNT for each project, and then derived a mean and standard deviation across those values. This yielded a mean NNS and NNT of 701 (range across projects: 1.7-8,705; SD: 1,669) and 8 (range across projects: 1–26; SD: 6), respectively. The latter NNS value confers a prevalence of detected TB in the screened population of 143/100,000.

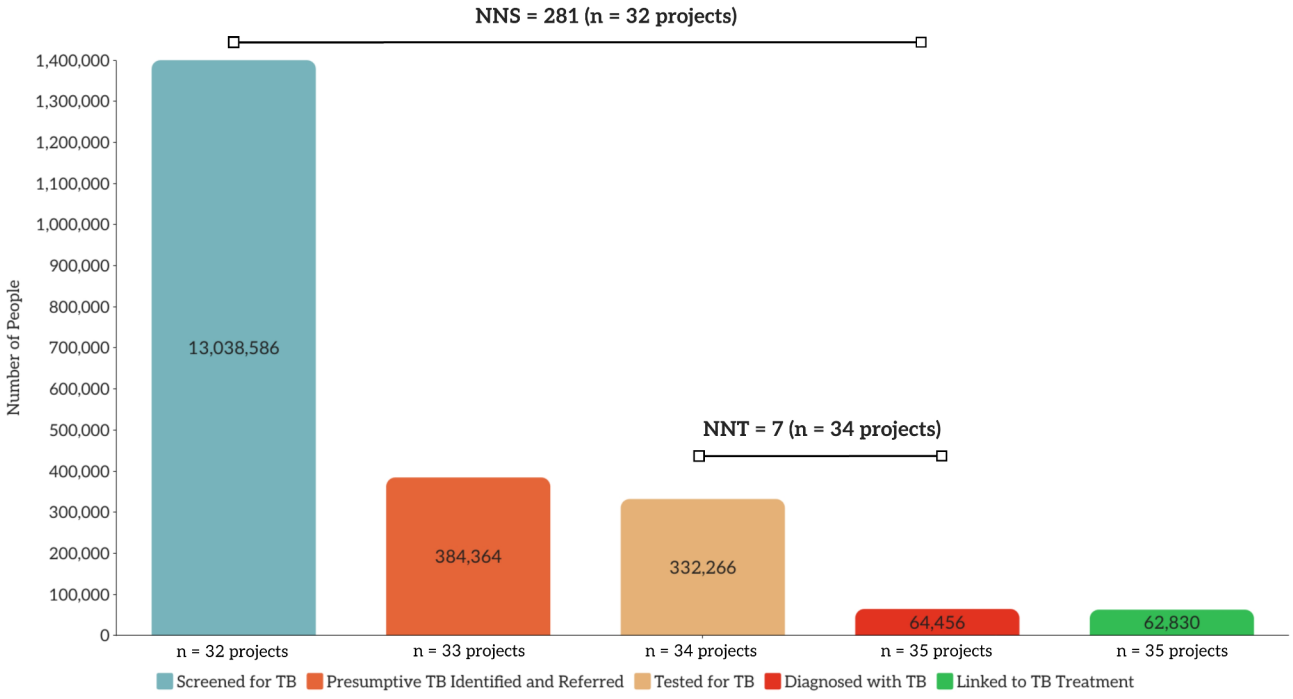

Fig. 2 Diagnostic cascade data for all private sector engagement projects. The numbers in this figure represent the total number of people with TB identified including three projects that did not report screening data and one that did not report testing data. NNS was calculated for only 32 projects, using a numerator of 13,038,586 people screened and a denominator of 46,474 people diagnosed with TB, and NNT was calculated for only 34 projects, using a numerator of 332,266 people tested and a denominator of 48,757 people diagnosed with TB

Additional notifications and PPE contribution

The projects were able to successfully link 62,830 people (97% of those diagnosed) to TB treatment and notification. Across the four waves of TB REACH funding in the respective evaluation areas, there were 61,123 additional notifications (from 246,845 during the comparator baseline period to 307,968 during the project period), reflecting a 25% increase. By comparison, across all waves the control areas showed a mean of 10% additional notifications during the project period (range – 9% in Wave 6 Scale-up to 22% in Wave 8). In each Wave, the change in TB notifications in evaluation areas showed more improvement than in control areas.

Overall, during the project period, 20% of the total TB notifications in the intervention areas were contributed by the PPE projects. This contribution of the PPE projects to the total TB notifications in the evaluation population was 11% during Wave 6, 26% during Wave 6 Scale-up, 30% during Wave 7, and 18% during Wave 8. Overall, across all waves, the ratio of additional notifications to PPE notifications is notably high, with a mean calculated across four waves together of 0.97 and a median of 0.61. However, the median ratios for each wave are as follows: 0.3 for Wave 6; 0.2 for Wave 6 Scale-up; 0.2 for Wave 7; and 1.4 for Wave 8.

Table 1 shows the spread and central tendency of the total, PPE and additional notifications by each TB REACH project in each funding wave. The mean values for PPE notifications were higher than the median values for all four waves, indicating the skewing effect of high value outliers. Similarly, in the additional notifications, the mean percentage increases above baseline were 4-fold (Wave 6 and Wave 6 Scale-Up), 1.3-fold (Wave 7) and 1.2-fold (Wave 8) higher than the respective median increases, suggesting the presence of high value outliers in all Waves. Standard deviations and interquartile ranges were also high for all four waves, indicating wide-ranging results for individual projects. Finally, the mean percentage increases in additional notifications were higher in the evaluation area than the control area for each individual wave: 20% (evaluation) vs. 5.0% (control) for Wave 6; 24% vs. -8.6% for Wave 6 Scale-up; 12% vs. 0.24% for Wave 7; and 35% vs. 22% for Wave 8.

Cost analysis

Throughout all four waves of TB REACH funding, a total of USD 13,870,891 was spent on project implementation with grants that ranged from USD 137,267– USD 949,240. Across all funding waves, the median project cost per person diagnosed and started on TB treatment was USD 481 (range across projects: 23 – 8,689; IQR 250-1,047). The equivalent mean cost was USD 221 and reduced over time from USD 650 (Wave 6), to USD 298 (Wave 6 Scale up), USD 188 (Wave 7) and USD 169

Table 1 Per-project PPE notifications, TB notifications, additional notifications, and cost per person started on TB treatment

Funding Wave	# of projects	Mean *n*	Standard Deviation *n*	Median *n*	IQR *n*
PPE-related notifications during the intervention period					
Wave 6	10	444	367	308	237–693
Wave 6 Scale-up	5	1886	1615	1587	776–2314
Wave 7	7	2536	3821	1177	630–1982
Wave 8	13	2401	4149	875	418–2449
Total notifications (public plus private) during the intervention period					
Wave 6	10	4530	4727	3041	2004–4231
Wave 6 Scale-up	5	7397	6889	4581	2880–7945
Wave 7	7	8474	6024	9121	4038–11,929
Wave 8	13	13,146	17,488	6504	3732–15,435
Additional Notifications (total notifications during the intervention period compared to baseline period)					
Wave 6	10	383	1,111	70	-34-427
Wave 6 Scale-up	5	615	2,108	261	-32-1417
Wave 7	7	874	2865	325	-48-826
Wave 8	13	3730	7775	1261	892–2872
Cost per person diagnosed with TB and started on treatment					
Wave 6	10	USD 650	USD 2521	USD 931	USD 496- USD 1217
Wave 6 Scale-up	5	USD 298	USD 492	USD 339	USD 261- USD 481
Wave 7	7	USD 188	USD 359	USD 390	USD 256- USD 500
Wave 8	13	USD 169	USD 907	USD 492	USD 125- USD 873
All waves	35	USD 221	USD 1496	USD 481	USD 250- USD 1047

(Wave 8). The variability of this cost metric on a per-project basis is depicted in Fig. 3, plotted against the variability in the number of notifications per project.

Mapping and baseline engagement in later waves by provider type

The level of detail in the data collection was increased after Wave 6, allowing us to analyze provider-specific metrics for the 3 subsequent waves. The baseline mapping exercises ($n = 25$ projects) documented 69,187 (range per project: 77 – 17,792) PPs in the intervention areas, of which only 1,272 (range per project: 0-470) (2%) had been engaged prior to the TB REACH projects. During the baseline year, these providers notified 9,537 (range per project: 0–2,709) people with TB (Table 2). The majority (35,233; 51%) of mapped PPs were private pharmacies and drug stores, followed by informal providers.

Engagement Per provider type

Of the 69,187 PPs who were mapped in the three later waves, there was a diverse number of PPs engaged per project (Fig. 4). Overall, 31% of mapped PPs or 21,206 (range per project: 55 – 5,335) were engaged by the projects (Table 3). The majority of the engaged providers were private pharmacies and drug stores (55%) or informal PPs/facilities (23%). Private labs, private formal facilities, and other providers constituted a minor portion of the total engaged providers.

Of all those engaged, 12,211 (58%) of these providers actively referred at least one person with TB symptoms during the intervention period. The highest percentage of engaged providers who were actively referring was recorded in private labs (76%, $n = 249$), followed by private formal facilities (65%, $n = 485$) and, at the lowest rate, informal private providers/facilities (49%, $n = 2,365$). The percentage of engaged providers who were actively referring increased from Wave 6 Scale-Up (31%) to Wave 7 (57%) and finally to Wave 8 (67%). Each active PP, on average identified 25 people with presumptive TB and referred them for diagnosis; this ranged from an average of 5 for each private pharmacy or drug store to 171 for each private formal facility.

Analysis of total PPE yield post-referral, per provider type

Of the individuals referred for TB diagnostic testing, the percentage who were tested was quite high across all types of referring providers (79-95%). Once tested, the percentage diagnosed with all forms of TB was highest among those identified by private formal providers (23%), with lower percentages for private labs (17%), informal private providers/facilities (13%), private formal facilities (13%) and private pharmacies and drug stores (10%).

Among all people with TB notified, the highest proportion of them originated at private formal providers (39%), followed by private formal facilities (24%), informal private providers/facilities (20%), private pharmacies and drug stores (8%), others (5%) and private labs (3%).

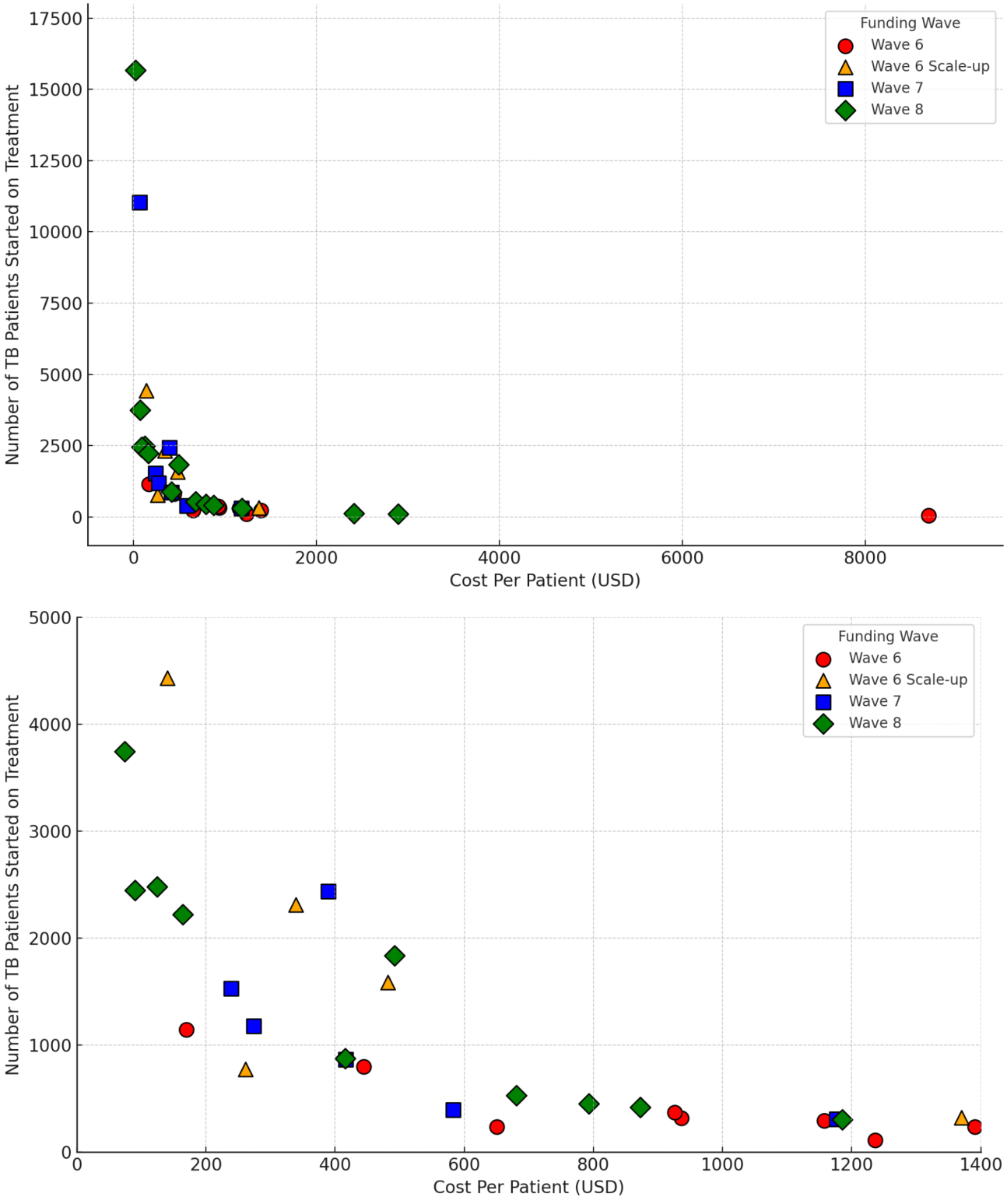

Fig. 3 Scatter plot for cost per patient and TB treatment yield per project ($n = 35$). Each TB REACH project is represented by a single point on the scatter plot and is color-coded depending on which TB REACH wave the project was implemented under. The point represents the number of TB patients diagnosed via PPE by that project and put on treatment, and the mean cost per PPE patient started on TB treatment. The top panel includes all 35 projects and the bottom panel excludes 5 outliers (the projects with either > 6000 patients diagnosed or >$2,000 cost per patient)

Table 2 Baseline provider Mapping and Engagement ($n=25$)

Provider Type	Number of Providers Mapped (% of total mapped)	Number of Providers Engaged Prior to TB REACH Project	Number of People with TB Notified by Providers During Baseline Year
Informal PPs/Facilities	15,731 (23%)	5	9
Private Pharmacies, Drug Stores	35,233 (51%)	5	33
Private Formal Providers	9711 (14%)	990	6678
Private Labs	860 (1%)	90	495
Private Formal Facilities	6765 (10%)	177	2317
Others	887 (1%)	5	5
Total	**69,187** (100%)	**1272**	**9537**

Geographic analysis of PPE

We compared key metrics across providers in Asia and Africa to assess regional variations. Providers in Asia accounted for the majority of total engagement, with 16,532 (78%) providers engaged compared to 4,674 (22%) in Africa. A similar trend was observed in the proportion of active providers, with 9,721 (59%) in Asia and 2,490 (53%) in Africa. In terms of individuals with presumptive TB identified, providers in Asia identified 245,621 individuals, amounting to an average of 1,826 individuals per active provider. In contrast, providers in Africa identified 53,012 individuals, but with a much higher average of 8,285 individuals per active provider. Diagnostic yield also varied, with Africa achieving a higher proportion of individuals with confirmed TB among those tested (17% in Africa vs. 13% in Asia).

Discussion

We report PPE results from 35 projects in 19 countries reflecting an almost USD 14 million investment that resulted in over 60,000 people with TB being diagnosed and treated across a wide range of engagement approaches and provider types. As a result of these projects– which aimed to strengthen screening and improve diagnostic and treatment linkages amongst PPs– these people were likely diagnosed earlier than they would have been without an active PPE approach, and by notifying and connecting them to the national TB programs they were linked to quality-assured TB treatment. This adds to the global evidence documenting large contributions of the private sector to TB diagnoses and notifications across many geographies and provides an updated picture of PP engagement. The wide variety of interventions also speaks to the importance of developing local solutions. Engaging the private sector cannot be a one-size-fits-all approach and achieve impactful results as the local context will dictate with who, and how to intervene. For example, the successful pharmacy engagement project in Pakistan identified people who had purchased anti-TB drugs in the private sector [30], whereas projects engaging drug sellers in Nigeria and Tanzania used models that identified people with presumptive TB because of the regulatory environments that limit purchases of anti-TB drugs.

Private providers contributed one-fifth of overall TB notifications in the intervention sites for these projects. This 20% PPE yield was similar to the 25% additional TB notifications (although there were variations in these metrics from project to project as well as by Wave). Overall, this suggests that the PPE interventions were additive for TB case finding. In addition, control areas saw smaller or no improvements across waves and overall.

These TB REACH projects documented impressive gains even though only about 31% of mapped PP were engaged, and only 58% of those engaged were active. This is consistent with other studies, which have shown that the majority of TB notifications come from a small proportion of providers [24]. Several published evaluations have documented similar or higher private sector TB notification contributions (of 23%, 44%, 11% and 17%, respectively) in earlier studies, primarily in Asia [9, 31–33], and a review of early TB REACH projects that included 6 PPE projects also showed improved TB notifications [34]. Another analysis documented 78 PPE projects in 16 countries but with only qualitative measures [35]. Publication bias likely influences published PPE results. It is noteworthy that our aggregated results include all operational projects and a wide range of outcomes (including nine projects that showed a negative number of additional notifications, and eight and six projects that contributed < 10% and < 5% of total notifications, respectively), and yet overall the impact on notifications is high. While many studies have shown impact of PPE interventions including larger Global Fund investments [19], more investments from donors or national programs would likely continue to deliver increased TB notifications in countries with strong private health sectors. Several TB REACH projects have been expanded and extended with larger investments from other donors including projects in Bangaldesh [24], Vietnam [36] and Pakistan [30] all using different locally tailored approaches. Importantly, the focus of TB REACH's targeted calls for proposals on PPE has helped bring more implementers into the PPE space. All TB

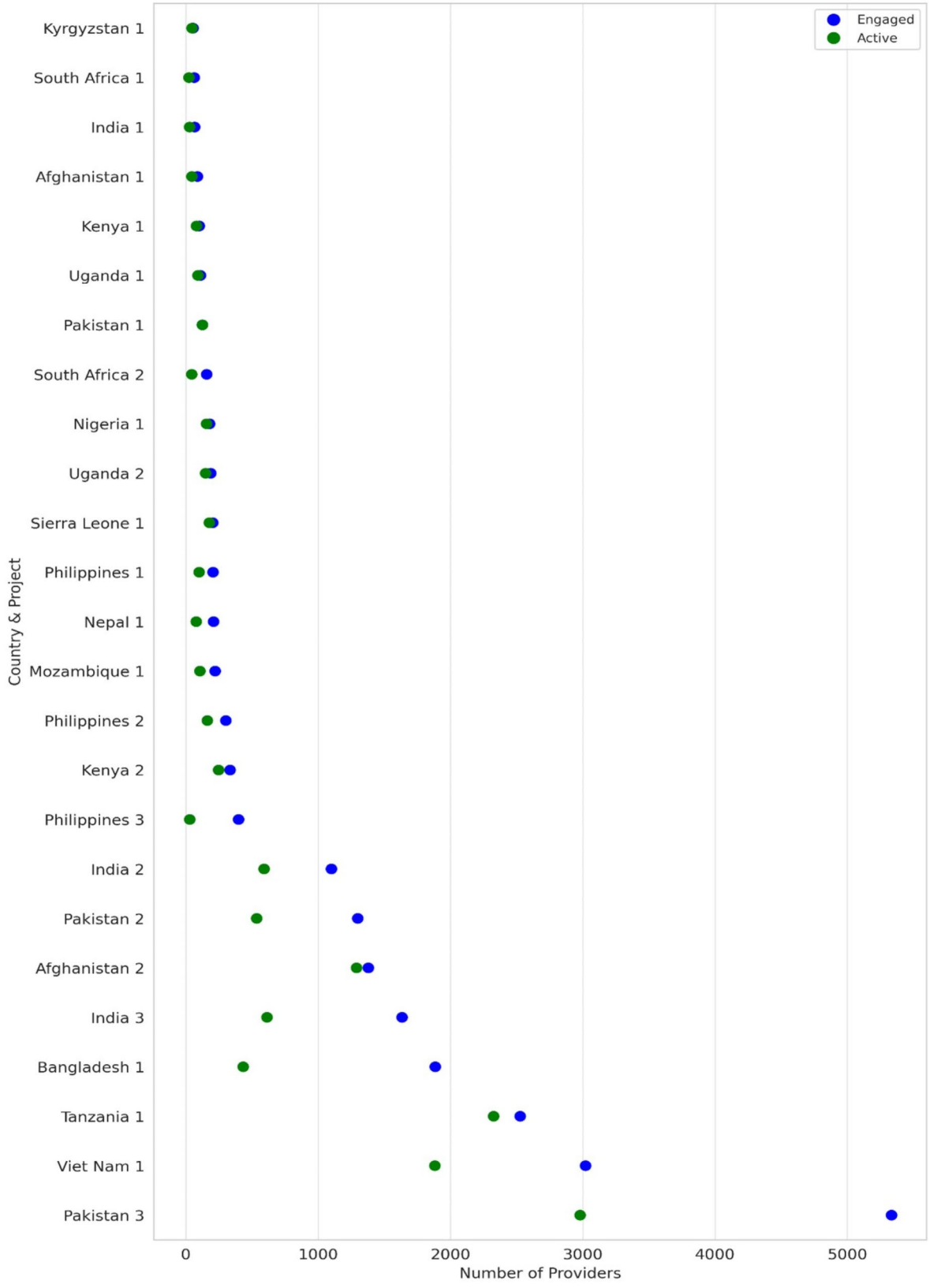

Fig. 4 Number of PPs engaged through each TB REACH project ($n = 25$)

Table 3 Engagement by types of PPs during intervention period ($n = 25$)

Provider Type	Number (%) of Providers Engaged [range]	Number (%) of Engaged Providers who are Active	Total Number of People with Presumptive TB Identified (average per active provider)	Number (%) of People with Presumptive TB Tested	Number (%) of People with TB Diagnosed, out of those Tested
Informal PPs/Facilities	4866 (23%) [7-1635]	2365 (49%)	64,414 (27)	60,316 (94%)	7789 (13%)
Private Pharmacies, Drug Stores	11,691 (55%) [3-5335]	7096 (61%)	37,578 (5)	30,470 (81%)	3022 (10%) [Final total: 18691*]
Private Formal Providers	3253 (15%) [7-568]	1812 (56%)	85,766 (47)	67,394 (79%)	15,171 (23%)
Private Labs	326 (1.5%) [4–75]	249 (76%)	7561 (30)	6743 (89%)	1163 (17%)
Private Formal Facilities	745 (4%) [2-322]	485 (65%)	83,131 (171)	69,430 (84%)	9311 (13%)
Others	325 (1.5%) [10–205]	204 (63%)	21,183 (104)	20,060 (95%)	1966 (10%)
Total	**21,206** (100%)	**12,211 (58%)**	**299,633 (25)**	**254,413 (85%)**	**38,422 (15%)** [Final total: 54091*]

*This figure represents the total number of people with TB identified including one pharmacy project that did not report the number of people tested. Since the necessary denominator is missing for this project, it is excluded when calculating the percentage of people diagnosed with TB out of all those tested

REACH partners supported under these waves have been local partners, and most were new to engaging private sector providers, highlighting the capacity building that can come from smaller grants for targeted approaches. We did not attempt to analyze individual factors that influence scale-up of interventions, partially because the outcome of continued funding is not always driven by results of the interventions, but by harder to measure factors that include interest from decision makers, timing of funding cycles, organizational leadership and influence.

Efforts are now being made to introduce more granular detail around private sector engagement in TB programming– including diagnostic cascade analysis and tracking contributions from different provider types– through public-private mix data dashboards [37]. The TB REACH project data collected and reported here can be seen as an initial test of such data collection approaches, albeit in a project setting. Other recent interventions have also used more nuanced approaches to monitor activities related to private sector engagement for TB including provider mapping exercises, and measuring engagement and participation in the intervention [25]. The enhanced TB REACH data framework was instrumental in allowing both TB REACH and the individual project teams to analyze the progress of the interventions, make necessary adjustments (such as targeting higher yield provider types [10]), and gauge their success in terms of increased TB case detection and notification rates and confirmed linkage to quality-assured treatment.

One important analytic approach with such data is TB diagnostic cascades [38]. Examination of each step in these cascades can show which steps are weaker or stronger. The TB REACH results indicated minimal losses between operational steps in the cascade (86% of those referred were tested, and 97% of those diagnosed were put on treatment) (Fig. 2). However, providers in the TB REACH projects appear to have had a somewhat low index of suspicion for TB, since they referred a low percentage for testing (3%) and a high percentage of those tested (15%) were diagnosed with TB. These two numbers are, respectively, at the lower and higher end of what is expected. The percentage of the general population that screens symptom-positive in TB prevalence surveys often ranges from 3 to 5% [39], and this percentage is typically higher in care-seeking populations. Meanwhile, an expected diagnostic positivity rate in programmatic settings in high TB burden countries is 10–15% [40]. Both of these numbers are also very sensitive to changes in the choice of symptom screening approach and where the screening is taking place [39]. The yield overall across provider types was high as providers presumably referred only after seeing very overt TB symptoms similar to passive case finding.

A large proportion of the projects engaged informal providers or pharmacies, and these also accounted for ~49% of the overall notifications. While several studies and reviews have been done on PPE, they almost exclusively focus on formal providers [2, 9, 35]. Previous publications on the role of informal providers in TB care included a 2021 review that identified eight studies [41], one study from India [42], and evaluations of small-scale pharmacy or drug seller engagement in TB [43–46]. Our results add further evidence indicating that engaging beyond the usual formal providers can reach

people where they are seeking care and lead to important improvements in TB notification and care.

The provider-specific data also enable a contrast between two pathways to impact. Pharmacies and drug stores had numbers that were high and low: they represented 55% of engaged providers, but referred an average of only 5 clients per facility. This contributed 35% of all TB notifications from the TB REACH projects. The corresponding numbers for private formal facilities (which often have multiple staff) had an opposite pattern of low and high: they were only 4% of all engaged providers, but produced 171 referrals per facility. This led to 17% of the total TB notifications. Thus, both pathways are important.

Between projects, we observed a wide range of values for the cost per additional TB notifications. TB REACH projects are designed to test new approaches to improving TB detection, and other TB REACH analyses have also shown a wide variation in results [47–49]. Documenting both successful and less successful results can help de-risk larger investments by other funding mechanisms, by clarifying which approaches are more or less likely to be successful. Notable outliers can be seen in Fig. 3: one Wave 7 and one Wave 8 project over-performed (very high numbers of PPE-related patients put on treatment per project, at a very low cost per treated patient); and one Wave 6 and two Wave 8 projects underperformed (very few patients per project, at a very high cost per treated patient). Excluding these five outliers from the analyses changed some values but did not alter the overall conclusions. The NNS changed from 281 to 324, the NNT remained at 7, the contribution of PPE to total TB notifications reduced from 20 to 18%, additional notifications dropped from 25 to 12%, and mean cost per person with TB treated increased from USD 221 to USD 330.

From earlier to later waves, there were increases in the percentage of engaged providers who were active (from 31 to 57 to 67% in the three later waves), and in the diagnostic positivity (from 10 to 13% to 15–19% in the four waves); meanwhile, the cost per case went down (from USD 650 to USD 298 to USD 188 to USD 169; Table 1). These waves generally represent different projects and teams, but these figures may suggest a process of learning on PPE strategies from earlier waves, expansion of more sensitive diagnostic tools and more efficient resource utilization.

For additional notifications, Wave 7 had the lowest mean percentage increases over baseline, likely due to the extensive overlap of its implementation period (October 2019– September 2021) with the most severe restrictions of the Covid-19 pandemic [50]. Wave 8 additionality was highest due to the overlap of some part of the baseline period with the Covid-19 restrictions and also with the exit from these same restrictions during the intervention period. In addition, the variability in additional notifications was particularly high for the two waves that overlapped most significantly with the entry into (Wave 6 Scale-Up) and exit out of (Wave 8) the worst of the Covid-19 pandemic, potentially because of the variable timing and programmatic impact across different projects of the restrictive public health measures. However, there were also signs of resilience in the TB REACH data: the PPE contribution to total notifications during Wave 7 (30%) was much higher than the Wave 7 additional notifications (mean and median of 12% and 9%). This suggests a robust contribution of the projects (and private sector) even as the health system as a whole was struggling.

Our findings indicate significant heterogeneity in success rates across PPE projects. While engaging the private sector is a core part of the global TB responses, the interventions must be tailored locally based on where and when people may be seeking care, and engagement strategies must respect the web of existing relationships that private providers (formal and informal) have developed. This will look different depending on geographies across but also within countries where rural areas may have a much heavier focus on informal providers compared to abundant private clinics in large cities for example. Mapping out the different providers and engaging them in discussions about how they work and their interest in engaging on TB helped prepare many projects to dictate interventions.

This study has several important strengths and limitations. Our costing analysis was based on total budgets rather than a rigorous costing study, but it also includes costs like the overheads and monitoring and evaluation that other publications often do not consider even though they are incurred. None of these interventions were controlled research studies although we did include control population data prospectively collected, and the data come from efforts in multiple different countries, based on the engagement of multiple different provider types using multiple approaches. The engagement approaches, and therefore the outcomes, may differ from those of other PPE TB initiatives in the same country. However, these data reflect all TB REACH PPE projects implemented during this period, and thus lack the publication bias which tends to favor positive results. The reporting approach also allowed us to have a coherent framework to document the results from these varied interventions.

Conclusions

By analyzing 35 projects in 19 countries, we have provided a granular picture of how PPE can be an important contributor to TB goals in diverse settings. Strong M&E is a critical contributor to the success of such efforts, as it enables PPE to be adjusted to suit a wide variety of

different health system contexts and PP behaviors– from small drug shops to large private hospitals. Tailoring PPE to the local context, rather than generic approaches is critical as setting-specific factors including patient pathways and local regulation are critical to developing impactful models. Such a learning approach, and the recognition of PPE as a critical strategy, is an essential requirement for a successful TB response.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-21806-4.

Supplementary Material 1

Acknowledgements
The data reported here are based on the hard work and dedication of the implementers of these 35 projects, who persisted despite the challenges of the COVID-19 pandemic. The views and opinions expressed in this paper are those of the authors and not necessarily the views and opinions of the United States Agency for International Development.

Author contributions
J.C., W.W., and M.T.R. conceived and planned the paper. M.T.R, W.W., M.I.B. and J.C contributed to analysis and the interpretation of the results. M.T.R, W.W. and J.C. wrote the first draft of the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors discussed the results and approved the final manuscript.

Funding
Not applicable.

Data availability
The data that support the findings of this paper are available from TB REACH secretariat. Data can be made available from the authors upon reasonable request to the corresponding author.

Declarations

Ethics approval and consent to participate
This paper utilized secondary data reported in the grant management system of TB REACH that was previously collected. As such, it did not require new ethics approval or consent to participate. The original data collection was conducted in compliance with ethical standards and the regulations of the relevant institutional review boards.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 21 July 2024 / Accepted: 5 February 2025
Published online: 18 February 2025

References

1. World Health Organization. Global tuberculosis report 2023. In. Geneva; 2023.
2. Lönnroth K, Uplekar M, Blanc L. Hard gains through soft contracts: productive engagement of private providers in tuberculosis control. Bull World Health Organ. 2006;84(11):876–83.
3. Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, Jha P, Mills A, Musgrove P. Disease control priorities in developing countries. 2006.
4. Wells WA, Uplekar M, Pai M. Achieving systemic and scalable private sector engagement in tuberculosis care and prevention in Asia. PLoS Med. 2015;12(6):e1001842.
5. World Health Organization. Engaging private health care providers in TB care and prevention: a landscape analysis. 2021.
6. Wells WA, Ge CF, Patel N, Oh T, Gardiner E, Kimerling ME. Size and usage patterns of private TB drug markets in the high burden countries. PLoS ONE. 2011;6(5):e18964.
7. Arinaminpathy N, Batra D, Khaparde S, Vualnam T, Maheshwari N, Sharma L, Nair SA, Dewan P. The number of privately treated tuberculosis cases in India: an estimation from drug sales data. Lancet Infect Dis. 2016;16(11):1255–60.
8. Stallworthy G, Dias HM, Pai M. Quality of tuberculosis care in the private health sector. J Clin Tuberculosis Other Mycobact Dis. 2020;20:100171.
9. Dewan PK, Lal S, Lonnroth K, Wares F, Uplekar M, Sahu S, Granich R, Chauhan LS. Improving tuberculosis control through public-private collaboration in India: literature review. BMJ. 2006;332(7541):574–8.
10. Highlights from TB program activities [https://shopsplusproject.org/nigeria].
11. Private Sector Collaboration Takes TB Services To Communities. [https://ihvnigeria.org/private-sector-collaboration-takes-tb-services-to-communities/]
12. Lönnroth K, Uplekar M, Arora VK, Juvekar S, Lan NT, Mwaniki D, Pathania V. Public-private mix for DOTS implementation: what makes it work? Bull World Health Organ. 2004;82(8):580–6.
13. Khan AJ, Khowaja S, Khan FS, Qazi F, Lotia I, Habib A, Mohammed S, Khan U, Amanullah F, Hussain H. Engaging the private sector to increase Tuberculosis case detection: an impact evaluation study. Lancet Infect Dis. 2012;12(8):608–16.
14. Arora VK, Sarin R, Lönnroth K. Feasibility and effectiveness of a public-private mix project for improved TB control in Delhi, India. Int J Tuberc Lung Dis. 2003;7(12):1131–8.
15. Thet Lwin Z, Sahu S, Owiti P, Chinnakali P, Majumdar S. Public-private mix for tuberculosis care and control in Myanmar: a strategy to scale up? Public Health Action. 2017;7(1):15–20.
16. Deo S, Jindal P, Gupta D, Khaparde S, Rade K, Sachdeva KS, Vadera B, Shah D, Patel K, Dave P. What would it cost to scale-up private sector engagement efforts for tuberculosis care? Evidence from three pilot programs in India. PLoS ONE. 2019;14(6):e0214928.
17. Arinaminpathy N, Nandi A, Vijayan S, Jha N, Nair SA, Kumta S, Dewan P, Rade K, Vadera B, Rao R. Engaging with the private healthcare sector for the control of tuberculosis in India: cost and cost-effectiveness. BMJ Global Health. 2021;6(10):e006114.
18. World Health Organization. Guide to develop a national action plan on public-private mix for tuberculosis prevention and care. In: *Guide to develop a national action plan on public-private mix for tuberculosis prevention and care.* edn.; 2017.
19. Yassin M, Kimbo L, Wandwalo E, Rashid A, Dzokoto A, Weber U, Stallworthy G. Leveraging Global Fund's investments to expand innovative public-private provider engagement in TB. IJTLD OPEN. 2024;1(6):250–7.
20. World Bank. Private Sector Engagement for Tuberculosis Elimination: India's Journey from Pilots to National Scale-Up (2012–2021). In. Washington, DC, USA; 2023.
21. Mailu EW, Owiti P, Ade S, Harries AD, Manzi M, Omesa E, Kiende P, Macharia S, Mbithi I, Kamene M. Tuberculosis control activities in the private and public health sectors of Kenya from 2013 to 2017: how do they compare? Trans R Soc Trop Med Hyg. 2019;113(12):740–8.
22. Ullah W, Wali A, Haq MU, Yaqoob A, Fatima R, Khan GM. Public–private Mix models of tuberculosis care in Pakistan: a high-burden country perspective. Front Public Health. 2021;9:703631.
23. Shah D, Vijayan S, Chopra R, Salve J, Gandhi RK, Jondhale V, Kandasamy P, Mahapatra S, Kumta S. Map, know dynamics and act; a better way to engage private health sector in TB management. A report from Mumbai, India. Indian J Tuberculosis. 2020;67(1):65–72.
24. Banu S, Haque F, Ahmed S, Sultana S, Rahman MM, Khatun R, Paul KK, Kabir S, Rahman SM, Banu RS. Social Enterprise Model (SEM) for private sector tuberculosis screening and care in Bangladesh. PLoS ONE. 2020;15(11):e0241437.
25. Shibu V, Daksha S, Rishabh C, Sunil K, Devesh G, Lal S, Jyoti S, Kiran R, Bhavin V, Amit K. Tapping private health sector for public health program? Findings of a novel intervention to tackle TB in Mumbai, India. Indian J Tuberculosis. 2020;67(2):189–201.
26. Guidance. note for TB private provider engagement [https://stoptb.org/assets/documents/global/awards/tbreach/W8_PPE.pdf]
27. TB REACH. Innovating to End TB [https://www.stoptb.org/accelerate-tb-innovations/tb-reach]

28. Blok L, Creswell J, Stevens R, Brouwer M, Ramis O, Weil O, Klatser P, Sahu S, Bakker MI. A pragmatic approach to measuring, monitoring and evaluating interventions for improved tuberculosis case detection. Int Health. 2014;6(3):181–8.
29. Singh AA, Creswell J, Bhatia V. Framework for planning and monitoring active TB case finding interventions to meet the global targets in the COVID-19 era and beyond: South-East Asia perspective. PLOS Global Public Health. 2021;1(11):e0000073.
30. Kirubi B, Eman KU, Lodhi UR, Fatima RK, Kazi GN, Tahmeena T, Shah SK, Creswell J. Enhancing tuberculosis case notifications through mapping sales of medicine in the private sector: a quasi-experimental study in Punjab province, Pakistan. BMC Health Serv Res. 2025;25(1):53.
31. Maung M, Kluge H, Aye T, Maung W, Noe P, Zaw M, Jost S, Uplekar M, Lönnroth K. Private GPs contribute to TB control in Myanmar: evaluation of a PPM initiative in Mandalay Division. Int J Tuberc Lung Dis. 2006;10(9):982–7.
32. Hamid Salim M, Uplekar M, Daru P, Aung M, Declercq E, Lönnroth K. Turning liabilities into resources: informal village doctors and tuberculosis control in Bangladesh. Bull World Health Organ. 2006;84(6):479–84.
33. Kumar M, Dewan P, Nair P, Frieden T, Sahu S, Wares F, Laserson K, Wells C, Granich R, Chauhan L. Improved tuberculosis case detection through public-private partnership and laboratory-based surveillance, Kannur District, Kerala, India, 2001–2002. Int J Tuberc Lung Dis. 2005;9(8):870–6.
34. Creswell J, Sahu S, Blok L, Bakker MI, Stevens R, Ditiu L. A multi-site evaluation of innovative approaches to increase Tuberculosis case notification: summary results. PLoS ONE. 2014;9(4):e94465.
35. Lei X, Liu Q, Escobar E, Philogene J, Zhu H, Wang Y, Tang S. Public–private mix for tuberculosis care and control: a systematic review. Int J Infect Dis. 2015;34:20–32.
36. Vo LNQ, Codlin AJ, Huynh HB, Mai TDT, Forse RJ, Truong VV, Dang HMT, Nguyen BD, Nguyen LH, Nguyen TD. Enhanced private sector engagement for tuberculosis diagnosis and reporting through an intermediary agency in Ho Chi Minh City, Viet Nam. Trop Med Infect Disease. 2020;5(3):143.
37. Public-Private Mix. (PPM) data dashboards for enhanced action and accountability to end TB [https://www.who.int/teams/global-tuberculosis-programme/public-private-mix-data-dashboards]
38. Subbaraman R, Nathavitharana RR, Mayer KH, Satyanarayana S, Chadha VK, Arinaminpathy N, Pai M. Constructing care cascades for active tuberculosis: a strategy for program monitoring and identifying gaps in quality of care. PLoS Med. 2019;16(2):e1002754.
39. Wells W. Onions and prevalence surveys: how to analyze and quantify tuberculosis case-finding gaps. Int J Tuberc Lung Dis. 2017;21(11):1101–13.
40. Piatek AS, Wells WA, Shen KC, Colvin CE. Realizing the 40 by 2022 commitment from the United Nations high-level meeting on the fight to end tuberculosis: what will it take to meet rapid diagnostic testing needs? Global Health: Sci Pract. 2019;7(4):551–63.
41. Thapa P, Jayasuriya R, Hall JJ, Beek K, Mukherjee P, Gudi N, Narasimhan P. Role of informal healthcare providers in tuberculosis care in low-and middle-income countries: a systematic scoping review. PLoS ONE. 2021;16(9):e0256795.
42. Dutta A, Pattanaik S, Choudhury R, Nanda P, Sahu S, Panigrahi R, Padhi BK, Sahoo KC, Mishra P, Panigrahi P. Impact of involvement of non-formal health providers on TB case notification among migrant slum-dwelling populations in Odisha, India. PLoS ONE. 2018;13(5):e0196067.
43. Bell CA, Ilomäki J, Pichenda K, Duncan GJ, Saini B. Referral of Tuberculosis symptomatic clients from private pharmacies to public sector clinics for diagnosis and treatment in C ambodia. J Eval Clin Pract. 2015;21(2):285–91.
44. Lönnroth K, Karlsson M, Lan N, Buu T, Dieu T. Referring TB suspects from private pharmacies to the National Tuberculosis Programme: experiences from two districts in Ho Chi Minh City, Vietnam. Int J Tuberc Lung Dis. 2003;7(12):1147–53.
45. Bigio J, Vasquez NA, Huria L, Pande T, Creswell J, Ananthakrishnan R, Bimba JS, Cuevas LE, Vo L, Bakker MI. Engaging pharmacies in tuberculosis control: operational lessons from 19 case detection interventions in high-burden countries. BMJ Global Health. 2022;7(4):e008661.
46. Smith F. Private local pharmacies in low-and middle-income countries: a review of interventions to enhance their role in public health. Tropical Med Int Health. 2009;14(3):362–72.
47. Blok L, Sahu S, Creswell J, Alba S, Stevens R, Bakker MI. Comparative meta-analysis of tuberculosis contact investigation interventions in eleven high burden countries. PLoS ONE. 2015;10(3):e0119822.
48. Creswell J, Codlin AJ, Andre E, Micek MA, Bedru A, Carter EJ, Yadav R-P, Mosneaga A, Rai B, Banu S. Results from early programmatic implementation of Xpert MTB/RIF testing in nine countries. BMC Infect Dis. 2014;14:1–12.
49. Rahman MT, Malik AA, Amanullah F, Creswell J. Improving tuberculosis case detection in children: summary of innovations and findings from 18 countries. J Pediatr Infect Dis Soc. 2022;11(Supplement3):S117–24.
50. World Health Organization. Global Tuberculosis Report 2022. In.; 2022.

Publisher's note