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Enhancing tuberculosis case notifications through mapping sales of medicine in the private sector: a quasi-experimental study in Punjab province, Pakistan

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Abstract

Introduction In Pakistan, almost one-third of people who develop tuberculosis (TB) are missed by the National TB Program (NTP). A considerable number of people with TB receive treatment in the private sector but remain unnotified. This study documents the outcomes of an intervention to identify people with TB through private pharmacy engagement, building on mapping TB medicine sales in Punjab Province.

Methods A comprehensive intervention was carried out in four districts of Punjab with high anti-TB drug sales, comprising a policy change requiring mandatory notification of TB medication sales, mapping and engaging pharmacies selling anti-TB drugs, reporting through a novel 'eTB' mobile application and providing support via a call center. We collected both historical and prospective TB notification data from the intervention and control districts. The primary outcome was the change in TB notifications during the intervention period compared with historical and control notifications.

Results Over the 12-month intervention period, 15,669 people with TB were reported from 2,943 pharmacies in four districts. Among the people identified, 88% were male ($n=13,673$), 95% had pulmonary disease ($n=14,969$), and 4,256 (27%) were bacteriologically confirmed. Chain pharmacies ($n=14$) contributed to 39% of the yield. TB notifications increased by 17,462 (+34%) over the baseline period compared with an 8% increase in the control districts. The number of bacteriologically confirmed notifications increased by 32% compared with 16% in the control districts. The proportion of bacteriological confirmation was similar before and during the intervention.

Conclusion The results of the largest TB intervention with pharmacies globally showed incredible potential to link people with TB who are receiving care in the private sector. Mapping TB medicine sales in the private sector with tailored interventions can contribute to closing the gap in notifications where anti-TB drug sales in the private sector are prevalent.

Key messages

What is already known on this topic?

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A significant number of people with TB receive care in the private sector as evidenced by the significant volumes of anti-TB medicines sold, particularly in countries with substantive private TB drug markets like Pakistan. However, there is still a gap in notifications, particularly from small scale private pharmacies. Most pharmacy-based TB interventions have been done at a small scale and have engaged pharmacies to refer people with TB-related symptoms for testing thus creating a potentially perverse economic incentive for participation.

What this study adds

• Using TB drug sales data can help target interventions engaging private pharmacies at a large scale. Enormous numbers of people with TB can be captured in the public notification system to close the existing notification gap.

• Private sector engagement approaches that support existing business models are more likely to create buy-in and more successful in increasing collaboration.

• In many countries, men with TB are missed more often than women, and this type of private sector intervention has the potential to bring the gap in TB notifications among men.

How this study might affect research, practice or policy

• A combination of regulatory approaches and enablers applied by NTPs could be useful in engaging with private sector, particularly for-profit private pharmacies in identifying people with TB who are currently missed.

• There is potential to improve case identification and management through enhanced data sharing between private pharmacies and public health authorities supported by intermediary agencies.

Keywords Private pharmacies, Private sector, Private provider engagement (PPE), Case notification, Mapping, Pakistan, Drug quantification

Introduction

Globally, more than 3 million people with tuberculosis (TB) were missed by National TB Control Programs (NTPs) in 2022 [1]. Many people with TB do not receive a diagnosis, while a considerable number are diagnosed and receive treatment but are not notified to NTPs [2–4]. Under-notification, which is more common in the private sector, is associated with questionable diagnostic and treatment approaches and an uncertain quality of TB care [5–7]. The private sector, particularly private pharmacies and other drug vendors, is often preferred in seeking care for chest symptoms for a variety of reasons including- lower costs, perception of better quality of services and convenient working hours among others [4, 8–10]. However, the massive numbers of such small-scale facilities in a fragmented private health sector, coupled with burdensome reporting processes for TB, limited financial and human resource capacities, and lack of engagement efforts by the NTPs, contribute to underreporting and suboptimal notification of TB by the private sector [3, 6]. Engaging private providers through public private mix (PPM) strategies is cost effective and can improve access to services, quality of care and reduce costs for people with TB [11, 12]. Enablers, including financial incentives, training, free diagnostics and drugs, and access to technology, among others, facilitate the engagement of private providers and can substantially increase the number of care providers detecting, treating, and notifying people with TB [13–16]. Approaches to engaging the private sector in many countries have traditionally targeted larger healthcare institutions, health facilities and not-for-profit organizations to conduct TB case management [6, 17]. Smaller establishments such as private pharmacies and individual practitioners are often encouraged to refer to those presenting with symptoms of TB owing to the complexity of engaging in multiple facilities and the relatively modest contribution these businesses provide, both in additional cases and in the range of services compared with higher-level private hospitals [6, 14, 15].

Quantifying the sales of TB medicines is an effective tool for estimating the magnitude of TB treatment in the private sector, particularly in countries with large private TB drug markets [18]. Previous studies have demonstrated that considerable volumes of anti-TB drugs are sold in the private sector, and in some countries, these private sales are comparable to volumes used to treat 50–100% of the estimated total TB burden [19, 20]. In India, for example, the private TB drug sale volumes in 2014 indicated that two million people received TB treatment in the private sector, which was three times the previously estimated burden [20]. In 2019, the private TB drug sales market share was between 15 and 54% among the 10 countries with the highest TB incidence globally [21]. Private drug sales data can therefore be useful for planning and targeting private sector interventions and contribute to drug

quantification for such NTPs [13, 22]. The utilization of retail drug outlets such as pharmacies, chemists, drug stores and vendors and the volumes of TB medicines dispensed suggest an opportunity to engage beyond referral models [6, 14, 23].

Pakistan has the fifth highest TB burden globally, yet almost one-third of the 608,000 people who developed TB were not reported in 2022 [1]. The private sector plays a major role in primary care in the country, accounting for up to 84% of initial healthcare seeking [21]. To address this, the National TB Program (NTP) in Pakistan has implemented four distinct PPM models to improve tuberculosis care and management. These models focus on engaging different sectors of the healthcare system: general practitioners (GPs) under PPM-1, non-governmental organizations (NGOs) under PPM-2, private hospitals under PPM-3, and networks of healthcare facilities operated by specific organizations under PPM-4 [24, 25]. Additionally the NTP is considering a fifth model that involves private pharmacies [25]. PPM interventions in Pakistan are supported by a structured incentivization system. General practitioners (GPs) receive a total incentive of 800 Pakistani Rupees (PKR) (approximately $3) for each diagnosed TB case, divided as follows: PKR 500 at patient registration and PKR 300 upon treatment completion. Furthermore, GPs receive free TB medicines from the NTP to dispense to patients. Private laboratories are also incentivized with PKR 100 (around $0.40) per sputum microscopy test performed.

Private pharmacies play a significant role in TB care [25]. In 2018, private sales of anti-TB drugs covered full courses for 164,000 adults. This figure represented nearly 50% of the total TB cases notified that year and was sufficient to treat 60% of the estimated missed cases in Pakistan in the same period [26]. Despite their significant role in access to medicines, less than 1% of the 67,000 privately operated pharmacies were formally engaged by the NTP in 2020 [21]. Engaging private pharmacies in TB case identification and notification could substantially reduce the detection gap could significantly narrow the existing TB detection gap.

Previous studies estimated that the engagement of private providers in Pakistan through the four types of PPM models contributed 40% of case notifications in 2021 [25]. The proposed fifth PPM model aims to engage 66,000 private pharmacies to enhance TB case detection and notification rates [25]. However, there is currently no documentation on the implementation framework for this PPM model or its potential impact on TB case notifications in Pakistan. Existing studies from pharmacy-based TB interventions in the region, have been conducted on a small scale and mostly pharmacies engaged to refer people with TB-related symptoms for testing thus creating a potential disincentive for participation [27–29]. The general objective of the study was to determine the impact of implementing a PPM model involving private pharmacies in Punjab province, Pakistan. The specific objectives were i) to measure the impact of engaging private pharmacies on TB case notifications, ii) to quantify the yield and the contribution of private pharmacies to TB notifications and iii) to describe the characteristics of people with TB seeking to buy medicines in private pharmacies.

Methods

Study design

We conducted a longitudinal quasi-experimental study in eight districts of Punjab province. Four districts were involved in the private pharmacy intervention and categorized as intervention districts. Another four districts that were not engaged in the pharmacy intervention were selected to act as control districts. The control districts had regular PPM 1–4 activities where private pharmacies were not engaged. The historical and prospective TB notification data from the eight districts were collected and monitored over a total period of 36 months, including a 12-month intervention period.

Study setting

Punjab Province is home to more than half of Pakistan's population [30] and the wide network of major pharmacy chains created an opportunity for this intervention. In 2018, pharmacies in Punjab accounted for the sale of 90,000 full courses of TB medications, comprising 55% of the total private-sector TB drug sales in the country [26]. The intervention was carried out between April 2021 and March 2022 in four districts of Punjab Province: Lahore, Multan, Rawalpindi, and Faisalabad. The four districts had a combined total population of 33.6 million [31]. The implementation districts were purposefully selected based on the volume of private anti-TB drug sales registered in NTP reports. We selected another four districts to act as controls: Muzaffar garh, Sardodha, Sialkot and Jhelum. The control population was selected on the basis of two factors—comparability with the evaluation population and being geographically separated—to minimize any spillover effects from or into the evaluation population. The evaluation and control districts are shown in Fig. 1.

The study population included all people presenting with prescriptions for TB fixed-dose combinations (FDC) medicines at the selected private pharmacies and notified the district TB authorities.

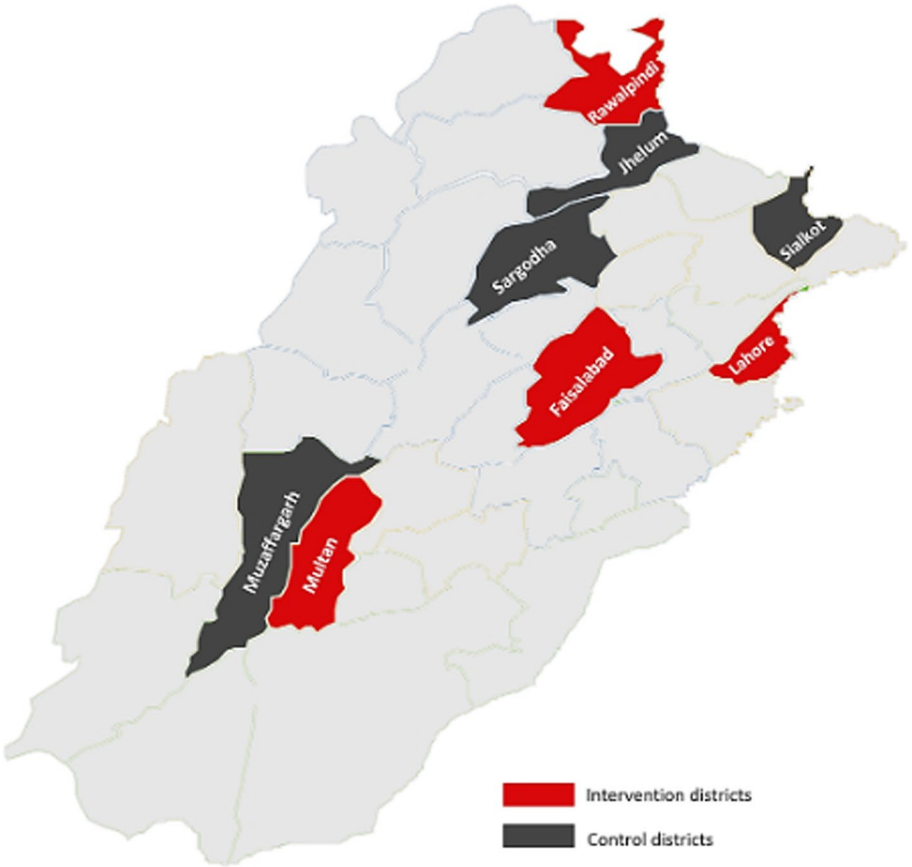

Fig. 1 Map depicting the project intervention and control districts, Punjab Pakistan

Intervention

In 2020, Dopasi Foundation conducted a study seeking to increase TB notifications through private TB drug sales by engaging private pharmacies in selected districts of Punjab Province. The intervention entailed four main components: 1) a policy change mandating notification of TB drug sales; 2) mapping and engagement of target pharmacies; 3) reporting and data capture via a novel mobile application 'eTB'; and 4) support to pharmacies and people with TB through a call center. These activities were carried out simultaneously. Advocacy efforts with the Punjab provincial health authorities resulted in an executive order directing the mandatory notification of all TB drug sales (12 Jan 2021 Departmental letter No.S.O. (pH) 9–10/94-II). The health authorities also reinforced earlier measures prohibiting over-the-counter (OTC) sales of TB medicines, as well as the ban on the sale of single TB drug formulations. A public information campaign, including a press conference and public radio announcements, was conducted to raise awareness (Additional file 1). The district health authorities sent official notices to all private pharmacies to inform them of the requirement for mandatory notification, and the Drug Regulatory Authority of Pakistan was engaged in reinforcing these measures during routine inspection.

To identify the target pharmacies, we engaged with the Pakistan Pharmaceutical Manufacturers Association and distributors, who supplied TB medicines to private pharmacies. Using TB medicine distribution data from the preceding eight (8) quarters, a cut-off of more than two (2) TB prescriptions per month of standard FDC containing two or more TB drugs, rifampicin (R), isoniazid (H), pyrazinamide (Z) and ethambutol (E), was used to prioritize eligible private pharmacies in the four districts. We made in-person visits to all eligible pharmacies to present the updated regulatory framework and encouraged them to engage in the intervention. Engaged pharmacies signed an agreement with the implementing organization (Dopasi Foundation, Pakistan). All the engaged pharmacies received training on notification processes, including the mobile application e-TB for data capture and branding material. Engaged pharmacies were those that visited or received support from the implementing organization during the selected period. Pharmacies were considered active if they notified at least one (1) person with TB during the reporting quarter.

The engaged private pharmacies used the eTB mobile application (https://etb.com.pk/) [32] to collect notification data according to the PTP guidelines. Prospective users were consulted in the pilot phase of the app to provide input on the usability of the app. The app was made available for the pharmacy owners to download from Google Play, where they registered with the drug sales licence number. When an individual or their representative presented a prescription for TB medicines, the pharmacy staff registered the patient and prescriber details in the eTB app and uploaded the prescription. In addition, contact information collected from the patient or the representative, was relayed to the call centre. Where essential data was missing, the call centre would follow up with individual patients using their contacts. Individual patient data were collated on a quarterly basis and sent to the respective district TB coordinator for notification. The district coordinator verified the patient details to control against double reporting among other facilities when the same person was treated in the public sector, and notified the case via the provincial TB reporting system. The pharmacies received a small payment of 100 PKRs ($0.4 USD) for each person notified with an accompanying prescription.

The centralized call center, hosted by the implementing organization, provided support to both private pharmacies and individuals receiving TB treatment through these pharmacies. In the initial stages of the intervention, the call center assisted pharmacies in the use of the eTB app and completion of notification forms. People with TB received information about the disease, details about medications and their common side effects, as well as personalized reminders for medication collection, sputum follow-up tests, and referrals to nearby health facilities. The call center collected missing patient data but did not contact prescribers.

Data collection

The case notification data were collected for 12 months of the intervention, between April 2021 and March 2022. Pharmacy level data were entered into the eTB mobile application in a standardized reporting format and included details of the reporting pharmacy and routine patient information: clinical and sociodemographic data, contact information, and treatment regimens. Prescriber data included the name and location of the health facility or clinician and was used to verify that the GPs were not currently engaged in the PPM-1 model. Pharmacy level data were extracted from the centralized online server into Microsoft Excel sheets for verification and aggregated by the district TB authorities on a quarterly (3-month) basis. District-level notification data disaggregated by age and sex were collected from the Punjab PTP official registry via Excel sheets for both the evaluation districts and the control districts every quarter.

Study outcomes

The main outcome of interest was the number of TB cases reported from NTP treatment registers within the reporting districts (i.e., evaluation population) in the intervention districts (April 2021–March 2022) compared with the same area's notifications from the previous year (April 2020–March 2021). We collected data on all forms of TB (total cases reported) cases as well bacteriologically confirmed cases for the purpose of project evaluation. In addition, we quantified the proportion of notifications contributed by private pharmacies in the evaluation population during the 12 months of the intervention.

Data analysis

Descriptive statistics were used to summarize and present the data, including the characteristics of the people diagnosed with TB. The private pharmacy engagement outputs and notification data were tabulated by district. Categorical variables are expressed as frequencies and proportions. To evaluate additional TB notifications, we subtracted the number of people with TB notifications during the baseline period 12 months prior to the intervention (1 April 2019–31 March 2020) from the number of people with TB notifications during the implementation period (1 April 2021–31 March 2022) [33]. We then calculated additionality via the double-difference approach [34]. This approach calculates the additive effect of the pre/postintervention difference in case notifications and adjusts the concurrent notification trend difference in a control area. For this analysis, we used modified baseline notifications 24 months prior to the intervention (April 2019–March 2020) to avoid measurement bias, as this period corresponded to normal activities. The true baseline period (April 2020 and March 2021) had unusual low notifications and coincided with the disruption of TB service delivery due to COVID-19 epidemic measures in Pakistan.

Ethical considerations

This study received a research waiver from the National TB Control Program ethical review board, as it was regarded as a routine active case-finding activity. The data collected were limited to the data used by the NTP and other partners for notification. All the data extracted for analysis were anonymized prior to analysis.

Results

Private pharmacy engagement activities

A total of 14,909 private pharmacies were mapped in the four evaluation districts. Among these, 64% ($n=9616$) of the pharmacies sold more than two (2) TB prescriptions/month during the mapping period and were considered eligible for the intervention. Among the eligible pharmacies, 31% ($n=2,943$) agreed to participate in the intervention, including fourteen (14) chain pharmacies with a total of 80 outlets and 2863 stand-alone facilities. The Rawalpindi and Faisalabad districts had the highest rates of eligible private pharmacies opting for the interventions. Table 1 shows the district breakdown of eligible pharmacies and those that agreed to participate in the intervention.

Persons with TB were notified through the intervention

A total of 15,669 people were notified through the eTB app during the 12-month period. Among these, 88% were male ($n=13,673$), and 3% were under the age of 15 years ($n=166$). The majority of those notified had pulmonary TB ($n=14,969$, 95%), and 4,256 (27%) had bacteriologically confirmed disease. Ninety-four percent (94%) of those notified were in the intensive phase of treatment and received the standard 4-drug fixed-dose combination (RHZE), with further 4.4% and 1.3% for the RHE and RH combinations, respectively. Table 2 provides a summary of people with TB notified through the e-TB app in the evaluation population. During the quarterly data verification exercise, a total of 109 cases were identified as having been double-reported and were dropped from the official NTP notification data.

Notification by private pharmacies

Among the 2943 engaged pharmacies, 1580 (54%) pharmacies reported having served at least one person with TB (active). The yield from the individual pharmacies varied, with the majority of the pharmacies ($n=1400$, 89%) notifying a total of ten or fewer people with TB during the 12 months of intervention. The 14 chain pharmacies notified a total of 6,120 people, accounting for 39% of all notifications. The breakdown of notifications by private pharmacies is detailed further in Additional file 2.

District notifications trends

A total of 68,183 people with TB were reported in the four districts during the intervention period (April 2021–March 2022), whereas 50,721 notifications were reported in the same districts during the baseline period (April 2019–March 2020). This corresponds to a 34% increase in notifications and represents an additional 17,462 people with TB. In the control districts, 22,935 people were notified during the baseline period and 24,780 during the intervention period, representing an 8% increase in notifications ($n=1,845$). Men accounted for 60% of the total notifications ($n=41,121$), whereas women accounted for 40% ($n=27,062$). A total of 4,685 children under 15 years were notified, representing 7% of all notifications. Figure 2 shows the notification trends in the intervention and control districts during the baseline and intervention periods.

Private pharmacy intervention contribution to district notifications

The intervention identified 15,669 people with TB from private pharmacies, accounting for 90% of all additional notifications and 23% of total TB notifications in the intervention districts. TB notifications by district are presented in Table 3.

Gender differences

The increase in notifications manifested differently by sex and intervention population. Together, the intervention districts registered an increase of 11% among female notifications ($n=2,716$) and a 56% increase in male notifications ($n=14,756$). The control districts registered modest increases in notifications of 7% ($n=729$) and 8% ($n=974$) in females and males, respectively. Table 4 below summarizes the sex-differentiated notification data for both populations.

Table 1 Number and proportion (%) of private pharmacies mapped, eligible and engaged for the intervention by district

	Total N (%)	Lahore n (%)	Multan n (%)	Rawalpindi n (%)	Faisalabad n (%)
Private pharmacies mapped	14,909	5,985	3,805	2,798	2,322
Eligible[a] private pharmacies	9,616 (64)	2,620 (44)	3,089 (81)	1,793 (60)	2,114 (91)
Engaged[b] private pharmacies n (%)	2,943 (20)	721 (12)	622 (16)	776 (26)	824 (35)

[a] Eligible = Pharmacies with sales of 2 or more standard TB FDC prescription months in the mapping period

[b] Engaged = Pharmacies visited at least once with the aim of recruiting them to the intervention

Table 2 Characteristics of the people with TB notified through private pharmacies by district

Variable	Category	Intervention district				
		Total N (%)	Lahore N = 3,931 (25.1)	Multan N = 3,301 (21.1)	Rawalpindi N = 3,244 (20.7)	Faisalabad N = 5,193 (33.1)
Age (years)	0–4	112 (0.7)	31 (0.8)	19 (0.6)	31 (1.0)	31 (0.6)
	5–14	407 (2.6)	94 (2.4)	109 (3.3)	69 (2.1)	135 (2.6)
	15–24	1013 (6.5)	259 (6.6)	287 (8.7)	196 (6.0)	271 (5.2)
	25–34	2631 (16.8)	784 (19.9)	470 (14.2)	710 (21.9)	667 (12.9)
	35–44	4402 (28.1)	1093 (27.8)	935 (28.3)	906 (27.9)	1468 (28.3)
	45–54	3905 (24.9)	1029 (26.2)	733 (22.2)	671 (20.7)	1472 28.3
	55–64	2199 (14.0)	430 (10.9)	500 15.1	438 (13.5)	831 (16)
	≥ 65	1000 (6.4)	211 5.4)	248 (7.5)	223 (6.9)	318 (6.1)
Sex	Male	13,673 (87%)	3489 (89)	2670 (81)	2735 (84)	4779 (92)
	Female	1996	442 (11)	631 (19)	509 (16))	414 8)
TB Type	Pulmonary TB	14,969 (95.5)	3737 (95)	3165 (96)	3111 (96)	4956 (95)
	Pulmonary TB Bacteriologically confirmed	4256	1059 (27)	892 (27)	883 (27)	1422 (27)
	Pulmonary TB Clinically diagnosed	10,713	2678 (68)	2273 (69)	2228 (69)	3534 (68)
	Extra-pulmonary TB (EPTB)	700 (4.5)	194 (5)	136 (4)	133 (4)	237 (5)

Impact of the intervention on TB notifications

We calculated additionality as a measure of the intervention impact. The project resulted in an increase of 22% ($n = 15,617$) for all forms of TB and 16% (4,509) for bacteriologically confirmed cases. Table 5 below shows the notification data and trends for the evaluation and control populations.

COVID-19 effects

We conducted a similar analysis to measure the extent of the effect of the COVID-19 disruption on TB notifications. When data from the 12-month period preceding the intervention were used as a baseline (April 2020-March 2021), the evaluation population registered a 74% ($n = 29,034$) increase in additional notifications for all forms of TB and 71% for bacteriological TB ($n = 7,733$). However, the best comparison is likely pre-COVID, where the yield and additionality are very similar. Table 5 shows the impact of the intervention compared with the modified baseline (pre-COVID) and the true baseline (during the peak COVID-19 period).

Discussion

We document the largest intervention globally targeting private pharmacies for TB notifications. Previous interventions involving private pharmacies have focused on referral systems for diagnosis and have been much smaller in scope [27, 28, 35–37]. Our findings demonstrate that PPM models engaging private pharmacies can significantly enhance TB case notifications in Pakistan. In the four intervention districts, TB notifications increased by 34% ($n = 17,462$), compared to an 8% increase in the control districts. Notably, the pharmacy intervention contributed 15,669 notifications, accounting for 90% of the additional notifications and representing 23% of the total notifications in the evaluation population. These findings corroborate existing research showing the immense utility of expanding TB-PPM activities to include private pharmacies through locally appropriate strategies [13, 19].

The intervention model integrated complementary approaches in its design, while maintaining the business model for the private pharmacies and the autonomy of people with TB to choose where to receive treatment. A mix of regulatory approaches and enabling factors, such as the business model, data capture support and incentives for referrals, have been effectively used for PPM in other settings [13, 38, 39]. This approach may have fostered better engagement and trust among stakeholders, contributing to the success of the intervention. Future studies could document how this might affect outcomes with a different engagement model.

The yield from the pharmacies differed across the pharmacies. Chain pharmacies emerged as "superreferrers",

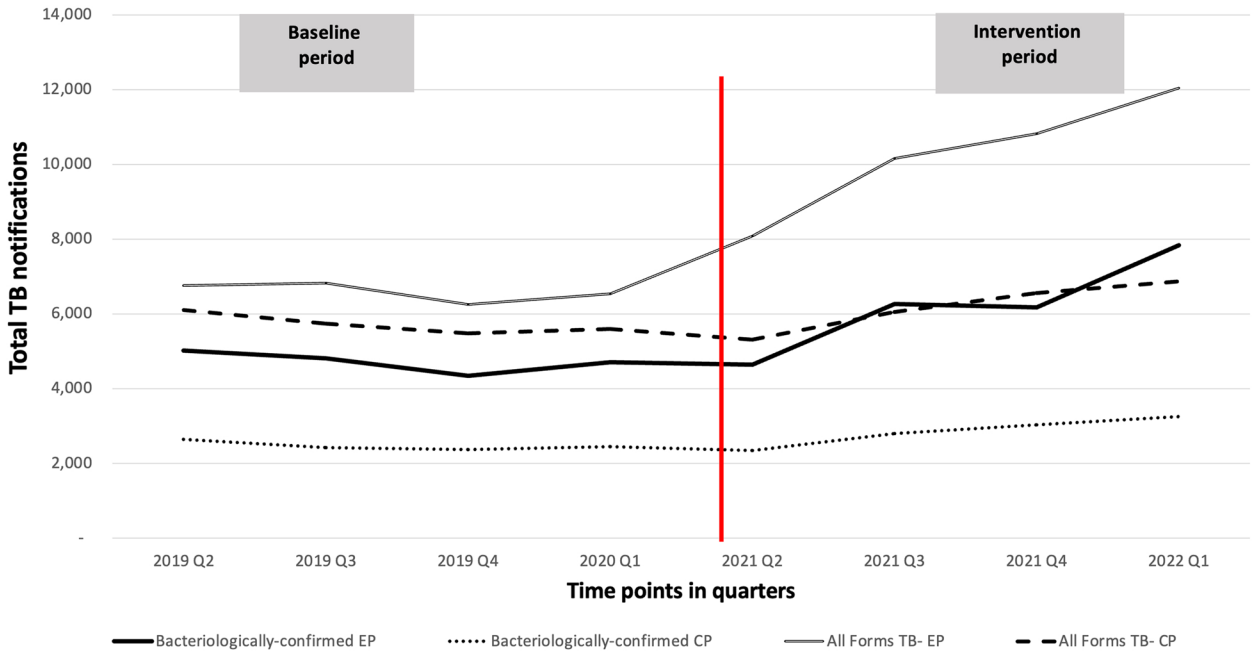

Fig. 2 Trend of pre- intervention and intervention TB notifications comparing intervention and control districts

Table 3 Table showing pharmacy contribution to additional and total district notifications

Districts	Notifications baseline period	Notifications intervention period	Additional notifications		Private pharmacy contribution through e-TB		
	April 2019-March 2020 n	April 2021-March 2022 n	n	%	Total n	Proportion of total notifications %	Proportion of additional notifications %
Faisalabad	12931	19143	6212	48%	5193	27%	84%
Lahore	19221	23346	4125	21%	3931	17%	95%
Multan	9449	13370	3921	41%	3301	25%	84%
Rawalpindi	9120	12324	3204	35%	3244	26%	101%
Total	50721	68183	17462	34%	15,669	23%	90%

Table 4 Sex-disaggregated TB notifications data by population

Sex	Period	Intervention population	Control population
Female	Baseline	24,346	10,851
	Intervention	27,062	11,580
	Additional notifications (n, %)	2,716 (11%)	729 (7%)
Male	Baseline	26,365	12,226
	Intervention	41,121	13,200
	Additional notifications (n, %)	14,756 (56%)	974 (8%)
Female to Male ratio (total TB notifications)	Baseline	0.9	0.9
	Intervention	0.7	0.9

Table 5 Additionality analysis by study area and baseline period considered

		Notifications	Baseline Notifications		Trend difference		% change	
		Intervention period April 2021-March 2022	Modified baseline period[a] April 2019-March 2020	True baseline period[b] April 2020-March 2021	Using modified baseline[a]	Using true baseline[b]	From modified baseline[a]	From true baseline[b]
All forms TB								
Notification impact					15,617	21,301	22%	29%
Study area	Evaluation districts	68,183	50,721	39,149	17,462	29,034	34%	74%
	Control districts	24,780	22,935	17,047	1,845	7,733	8%	45%
Bacteriologically confirmed cases								
Notification impact					4,509	6,157	16%	13%
Study area	Evaluation districts	24,932	18,890	14,591	6,042	10,341	32%	71%
	Control districts	11,423	9,886	7,239	1,537	4,184	16%	58%

[a] Modified baseline = data from the pre-COVID-19 period and represents the true baseline

[b] True baseline = data from the immediate period prior to intervention at the peak of the COVID-19 disruption

contributing close to 40% of the notifications. The super-referrers concept has been described in India, where a section of the targeted practitioners contributes especially high yields and could be targeted to increase the efficiency gains of PPM [13]. However, while close to 90% of the engaged pharmacies notified 10 people with TB or less, during the intervention, they still contributed more than a third (34%) of the notifications, almost as much as the super-referrers did. This demonstrates the complexity of engaging with small front-line providers in countries with a fragmented health system, particularly at the primary care level [4, 6, 14]. Engaging these small facilities, including pharmacies, laboratories and drug vendors, is essential in finding people with TB who are missed, as they are engaged in service delivery at primary care facilities [8, 9]. The funding support for PPM interventions should therefore not be based purely on efficiency but rather be a mix with coverage of both high- and low-yield enterprises if we are to reach the missing millions.

Approximately 27% of people with TB received bacteriological confirmation during this intervention. In other large-scale PPM interventions, the proportion was slightly greater, but in the first year of the intervention, it was similar [29]. We did not intervene with the clinicians making the diagnosis and only captured the outcome, which provides a good picture of private sector practices in Pakistan. Even in the public sector, bacteriological confirmation in Pakistan is only approximately 50% [1]. The majority of those notified were evaluated by a respiratory physician or GPs with TB training, which mitigated the risk for TB misdiagnosis. However, future projects that involve private pharmacies may need to incorporate a complementary system of sputum testing and referrals to confirm the diagnosis and rule out rifampicin resistance. We view this study as a first step that creates trust with pharmacies and supports the choice of people with TB to seek care from private providers. Future interventions should extend to improving the quality of care, including changing clinical behaviours among referring clinicians and standardizing prescription patterns while still maintaining the interests of pharmacies in TB drug sales.

Our results suggest that the vast majority of those notified presented to pharmacies early during the intensive phase of treatment, with more than 90% receiving the standard 4 drug combination (RHZE). This opens opportunities for more comprehensive PPM interventions, such as counselling and monitoring of side effects, contact tracing, and social support to patients through their treatment. Further studies to investigate whether patients remained in the private sector or switched to public facilities during treatment could be helpful for the design of PPM interventions.

There were also a few distinctive observations from this intervention. Men constituted a majority (87%) of the notifications reported through e-TB and contributed more to the additional TB notifications in the evaluation population. This may be attributed to the design of the intervention. Previous studies have shown that men are more likely to seek care from private facilities due to health system barriers such as prolonged waiting times, working hours that overlap with clinic operating hours in the public sector, which poses a barrier to men, and the capacity to pay for private services compared with women [40–42]. However, other large PPM studies reported a more balanced ratio [29]. In Asia, men with TB are more likely to be missed by health systems [43,

44]. In Pakistan, as in many other countries, men have a higher TB incidence than women do and are missed in greater proportions [45]. These results demonstrate the potential to extend private sector engagement interventions to reach more men in Pakistan and investigate gender-specific barriers to accessing TB care in both the private and public health sectors.

Our results also reinforce the need to engage with the different stakeholders from project inception, design and during the implementation. This is consistent with global guidance on PPM [18]. In our study, stakeholders including the government authorities, drug manufacturers, medical distributors, private practitioners, pharmacists and people with TB were engaged to increase the efficiency and effectiveness of the intervention.

Study limitations

This study was carried out within programmatic settings and represents the real-world implementation of a novel intervention. Only one-third of the eligible pharmacies agreed to participate in the intervention. This could potentially introduce a selection bias, as the participating pharmacies may have been the early adapters, more motivated to notify TB cases or possessed better in-house capacity to manage the processes, and that could result in an overestimation of the intervention's impact. It may also be due to those pharmacies filling more prescriptions for TB. A PPM study from south India looking at engagement and referral found a 22% participation rate among private providers while a recent large initiative that included chemists/drug vendors only was able to engage 10% of mapped providers [29, 46]. The intervention was focused mostly on notification and data was missing to inform the treatment journey and treatment outcomes. This is a first step in private sector engagement and can be improved in future studies. Additionally, we did not collect data on how long people bought their drugs and continued their treatment, which could be documented in future work.

Since our intervention was not a controlled trial, we cannot say that the intervention alone caused more notifications; however, all the signs point to a high likelihood of impact. The comparability between the yield and the additional cases strengthens the evidence suggesting that the intervention was impactful.

Conclusion

A significant number of people with TB in Pakistan who are currently missed can be identified through mapping TB drug sales in the private sector and targeting interventions accordingly. Securing the confidence of private healthcare providers is a key component of effective TB-PPM, in combination with an appropriate mix of regulatory and enabling factors. Finally, the TB response should incorporate the use of private drug sale data to estimate the TB burden and target interventions, particularly in countries with large private markets. This information can support policy makers in TB program planning and as an investment case for engaging smaller practitioners in TB-PPM models.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-024-12202-6.

Supplementary Material 1.

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Patient and public involvement

Several stakeholders were engaged in developing the study. The NTP and Pakistan Manufactures Association provided a method for targeting engaged pharmacies via retrospective TB sales data. The pharmacists and their staff themselves provided feedback on the eTB app and its usability. Finally, the results of the intervention were shared at various rates with the Punjab state- and district-level Ministry of Health Representatives and the pharmacists in the four participating districts.

Authors' contributions

K.U., K.S., G.K. and J.C. conceived and planned the study. B.K., K.U., K.S., G.K. and J.C. developed the protocol. K.U., U.L., R.F., G.N., and S.U. contributed to the implementation of the research. B.K., K.U., K.S., T.T., G.K. and J.C. contributed to the analysis and interpretation of the results. B.K. and J.C. wrote the first draft of the manuscript. All the authors provided critical feedback and helped shape the research, analysis and manuscript. All the authors discussed the results and approved the final manuscript.

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Data availability

The data that support the findings of this study are available upon request from and with the permission of the Pakistan National TB programme.

Declarations

Ethics approval and consent to participate

This study received a research waiver from the National TB Control Program ethical review board. The study adhered to the tenets of the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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