Engaging the private sector to increase tuberculosis case detection: an impact evaluation study

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Summary

Background **In many countries with a high burden of tuberculosis, most patients receive treatment in the private sector. We evaluated a multifaceted case-detection strategy in Karachi, Pakistan, targeting the private sector.**

Methods **A year-long communications campaign advised people with 2 weeks or more of productive cough to seek care at one of 54 private family medical clinics or a private hospital that was also a national tuberculosis programme (NTP) reporting centre. Community laypeople participated as screeners, using an interactive algorithm on mobile phones to assess patients and visitors in family-clinic waiting areas and the hospital's outpatient department. Screeners received cash incentives for case detection. Patients with suspected tuberculosis also came directly to the hospital's tuberculosis clinic (self-referrals) or were referred there (referrals). The primary outcome was the change (from 2010 to 2011) in tuberculosis notifications to the NTP in the intervention area compared with that in an adjacent control area.**

Findings **Screeners assessed 388 196 individuals at family clinics and 81 700 at Indus Hospital's outpatient department from January–December, 2011. A total of 2416 tuberculosis cases were detected and notified via the NTP reporting centre at Indus Hospital: 603 through family clinics, 273 through the outpatient department, 1020 from self-referrals, and 520 from referrals. In the intervention area overall, tuberculosis case notification to the NTP increased two times (from 1569 to 3140 cases) from 2010 to 2011—a 2·21 times increase (95% CI 1·93–2·53) relative to the change in number of case notifications in the control area. From 2010 to 2011, pulmonary tuberculosis notifications at Indus Hospital increased by 3·77 times for adults and 7·32 times for children.**

Interpretation **Novel approaches to tuberculosis case-finding involving the private sector and using laypeople, mobile phone software and incentives, and communication campaigns can substantially increase case notification in dense urban settings.**

Funding **TB REACH, Stop TB Partnership.**

Introduction

Although free tuberculosis screening and treatment is available through national tuberculosis programmes (NTPs) in most countries, an estimated 1·45 million people die from tuberculosis every year, making it one of the leading infectious causes of adult deaths globally.[1] One important reason for this high death toll is inadequate case finding; more than 3 million of the estimated 8·8 million new cases annually are not notified. Many of these cases are either never diagnosed or receive treatment in the private sector.[2] Untreated patients continue to transmit tuberculosis and those treated incorrectly can develop drug resistance; in both cases, mortality is high.[3]

In Asian megacities, 50–80% of symptomatic tuberculosis patients preferentially seek care in the private sector.[4–7] Patients are often unaware of the free services available, perceive government services to be of poor quality, or are deterred by long waiting times and inconvenient hours.[8–10] At both government and private facilities, many tuberculosis cases are missed because suspects are not identified (ie, symptoms are not screened for or not recognised, or a diagnositic test is not requested).[11] Although there has been some success in engaging private health providers in Asian cities, persuading these providers to identify, notify to NTPs, and treat tuberculosis cases has been challenging.[12–14]

Harnessing the private sector has long been recognised as a missing component in global efforts against tuberculosis.[15] It is unlikely that airborne diseases such as tuberculosis will be eliminated without novel approaches to ensure that patients who present in the private sector have access to appropriate diagnostics and free medication. In settings where strict private-sector regulation is unlikely, incentive-based approaches will be necessary to ensure that high-standard tuberculosis diagnosis and treatment become the norm, rather than the exception.

An optimum case-detection strategy for dense urban settings with mixed public and private care providers would need to engage the private sector, be simple to implement and economically scaleable, and yield high numbers of previously unidentified or unreported tuberculosis cases. We sought to measure the effect of a multifaceted tuberculosis case-detection strategy in Karachi, Pakistan.

Methods

Study design

We retrospectively assessed a multifaceted case-detection strategy that targeted private health-care facilities within a section of Karachi, by comparing the number of cases notified to the NTP in the intervention area with the number of cases notified in an adjacent section of Karachi, over a 1 year period. The adjacent geographical area was identified as a suitable control population by the NTP and an independent monitoring and evaluation agency, through the TB REACH initiative. The control area shared several characteristics with the intervention area, including population demographics, income levels, availability of historical data for comparison before and after the intervention, and the absence of any other significant interventions for tuberculosis case detection. Additionally, the geographical proximity of the two sites meant that the frequent political disturbances in the city affected the control area in a similar way.

Setting

In 2010, the population of Pakistan was 173·6 million, with Karachi the largest city at 18 million;[16,17] the country ranked 128th on the Human Development Index, with an average per capita income of US$1050.[18,19] In the same year, Pakistan had an estimated annual tuberculosis incidence of 231 per 100 000, a prevalence of 364 per 100 000, and a case-detection rate of 65% (all forms).[1]

The estimated 2011 mid-year population was 915 767 in the intervention area (Korangi and a part of Bin Qasim) and 1 213 226 in the control area (Landhi and Shah Faisal).[20] Both areas comprise lower-income households from all major ethnic groups of Pakistan. Annual case-notification data for Karachi from 2008–11 were accessed through the Provincial TB Control Program—Sindh (unpublished). In 2010, 1569 new tuberculosis cases were detected through eight NTP reporting centres in the intervention area (case-notification rate of 176 per 100 000), and 547 cases were detected through five NTP centres in the control area (46 per 100 000). Five of the eight NTP reporting centres in the intervention area are private facilities, including Indus Hospital, a 150-bed centre that provides free care. The hospital's outpatient department has around 300 general visits and 400 specialty clinic visits each day, and the tuberculosis clinic sees around 350 patients daily. Indus Hospital notified 641 susceptible tuberculosis cases to the NTP in 2010 (40·8% of all cases in the intervention area). In addition to three other large (>100 bed) private hospitals, more than 30 small private hospitals and birthing centres and 120 private family clinics were serving the intervention area at baseline.

Procedures

To increase uptake of free services for tuberculosis diagnosis and treatment, we implemented a year-long mass communications strategy in the intervention area. We used billboards, cable television advertisements, posters, and flyers to encourage people with 2 or more weeks of productive cough to seek care at one of the family clinics or Indus Hospital, linking messages across all media platforms. Signboards at family clinics advertised free tuberculosis screening and treatment linked to Indus Hospital, and banners were placed at major street junctions near the clinics. Two local cable campaigns in March and October, 2011, included hourly 90–120 s informational videos highlighting the signs and symptoms of tuberculosis and the free diagnostic and treatment services available.[21,22] Self-referrals to Indus Hospital were surveyed about their motivation to come for screening.

Local residents in family-clinic catchment areas were invited to apply as screeners. We did brief interviews to assess work experience, oral presentation style, and comfort with using a mobile phone. Candidates had training sessions on NTP guidelines for community health workers on tuberculosis awareness, screening, and treatment,[23] including sputum handling and counselling of patients. Screeners were stationed at 54 geographically dispersed family clinics that reported serving 50 or more patients per day. Screeners at these clinics worked on an incentive-based package, with varying schedules that focused their time at peak clinic hours. Four salaried screeners were stationed at Indus Hospital's outpatient department, from 0730–1600 h Monday–Friday. 12 project monitors (community health workers with at least 5 years of experience) supervised small groups of screeners, managed specimen collection and drug delivery, and ensured every reported tuberculosis case was unique by visiting homes and taking global positioning system coordinates.

Patients and their escorts who attended family clinics and the outpatient department were assessed for tuberculosis symptoms by screeners. Screeners used an electronic form on a mobile phone that was linked to conditional cash transfers. Anyone with a cough of 3 weeks or more in duration (or 2–3 weeks of productive cough), a previous history of tuberculosis, or a family member currently diagnosed with the disease were suspected to have tuberculosis (figure 1). Individuals who came directly to Indus Hospital's tuberculosis clinic without first being screened at a family clinic or the outpatient department (self-referrals) and those suspected of having the disease who were referred to the tuberculosis clinic from other clinics at Indus Hospital or from outside facilities (referrals) are reported separately (table).

Patients suspected of having tuberculosis were requested to provide a spot sputum and an early morning sputum specimen. All laboratory testing was done at Indus Hospital in compliance with the National Reference Laboratory's external quality-assurance process for sputum microscopy. Monitors collected sputum containers from family clinics and transported them to Indus Hospital, recording collection and submission times on their mobile phones. Sputum test results were reported as text messages to family doctors and patients.

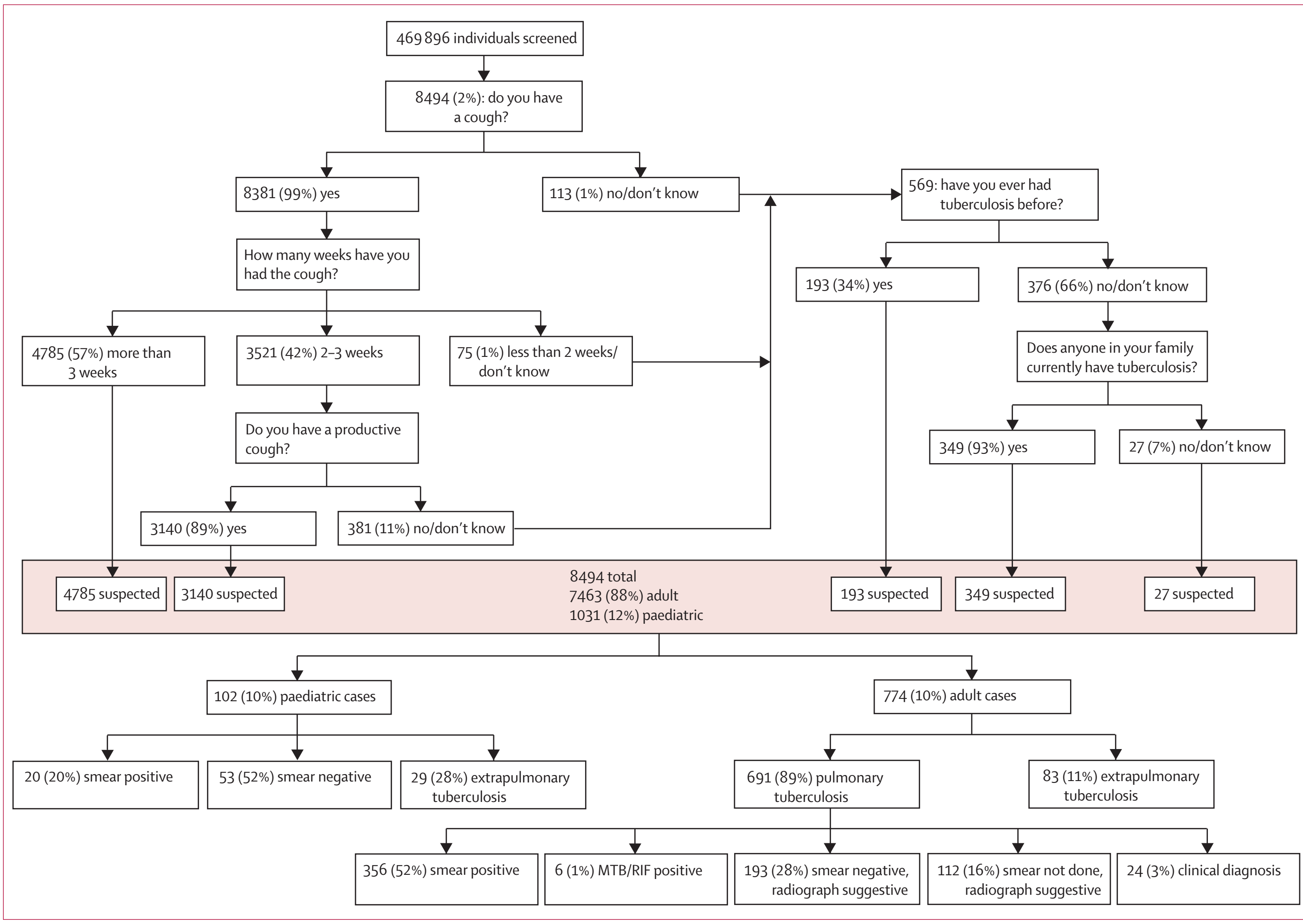


Figure 1: **Screening profile of 8494 individuals suspected of having tuberculosis identified at family-clinic waiting rooms and Indus Hospital's outpatient department**
MTB/RIF=mycobacterium tuberculosis and resistance to rifampicin.

A chest radiograph was requested for all patients suspected of having tuberculosis with negative smear results, and DNA testing (GeneXpert mycobacterium tuberculosis and resistance to rifampicin [MTB/RIF] assay, Cepheid, Toulouse, France) was done for 388 in whom radiographs suggested tuberculosis. All patients with suspected tuberculosis who were younger than 15 years, those with negative smear results but suggestive radiograph, and those suspected of having extrapulmonary disease were referred to Indus Hospital for diagnosis by specialists. Pulmonary tuberculosis was diagnosed if a patient had at least one positive acid-fast bacilli smear result, a positive MTB/RIF assay, or a chest radiograph suggestive of tuberculosis and clinical signs and symptoms as diagnosed by a specialist or family doctor. A single radiologist read all chest radiographs. Individuals diagnosed with tuberculosis were offered free treatment and all cases were notified to the NTP through Indus Hospital.

Screeners at family clinics received a monthly stipend of \$23·50 (exchange rate \$1=PKR 85), plus cash incentives for submitting a daily phone report (\$0·18), procuring an acceptable sputum sample (\$0·88), and identifying a smear-positive case (\$11·80) or other form of tuberculosis (\$5·88). Additional incentives were provided for treatment initiation (\$1·76) and follow-up visits (\$0·58). Screeners at Indus Hospital's outpatient department received a fixed monthly salary ranging from \$82·4–115·3.

Two software programmers who custom designed the mobile phone software used by screeners to collect, submit, and retrieve data continued to improve performance and expand functionality throughout the year. The system operates on any Java-enabled phone with general packet radio service (GPRS) capability. We used Nokia 2710, Nokia 6700, and Nokia X2-05 phones. The system allowed data entry and retrieval to a central database at the time of screening, identification of patients suspected of having tuberculosis via an interactive algorithm (figure 1), and scheduling of sputum collection, treatment initiation, clinic visits, and drug dispersal. Screeners were required to attempt three phone calls and two home visits to patients who were identified as cases but never initiated treatment—ie, those about to default.

Personal details—including name, address, phone number, and national identification card number (for adults)—were recorded in compliance with NTP requirements for preventing double counting or fraudulent case reporting, to permit mapping of patients to intervention or control areas and facilitate defaulter tracing. The system required a username and password for role-based access to forms and patient data. Submitted forms generated an electronic trail that allowed monitoring and ranking of screener performance and dispersal of financial incentives. The software code will be freely available under an open-source licence by November, 2012.

The institutional review board at Interactive Research and Development approved the study. Patients suspected of having tuberculosis were required to provide verbal consent and could refuse screening and treatment at any time. All screening, diagnostic, and treatment algorithms were in accordance with NTP guidelines and were approved by the NTP at the start of the project.

Statistical analysis

We measured the overall effect of the intervention strategy by comparing the percentage change in case notifications by NTP reporting centres (2011 relative to 2010), and in annual case-notification rates (2011 relative to 2008–2010) in the intervention versus control areas. By use of Poisson regression analysis for count data, we calculated the overall difference between the change in case notifications in the intervention area and the change in case notifications in the control area from 2010 to 2011. We used negative binomial regression for overdispersed count data to examine the association between the number of cases notified per quarter from 2008–11 at Indus Hospital, the intervention area (excluding Indus Hospital), and the control area, before and after the start of the intervention. A partial linear model using splines with knots at quarter 1, 2011, was used to assess the effect of the intervention on quarterly case-notification rates for these three groups. We used one-way ANOVA to compare mean age, a χ^2 test for homogeneity of proportions across sites (ie, family clinics and Indus Hospital's outpatient department, tuberculosis clinic self-referrals, and tuberculosis clinic referrals), and a non-parametric test for trends to identify changes over time within a site. Analysis was done with Stata/IC, version 11.

Role of the funding source

This study was funded by the TB REACH initiative of the Stop TB Partnership. The sponsor had no role in the study design or data collection. The sponsor was involved in monitoring overall project performance through quarterly reports. A member of the TB REACH secretariat (JC) was involved in the data analysis, interpretation, and writing the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

	Total	Family clinics	Indus Hospital outpatient department	Indus Hospital tuberculosis clinic, self-referrals	Indus Hospital tuberculosis clinic, referrals	p value*
Individuals screened	469 896	388 196	81 700	..	..	..
Suspected tuberculosis	8494 (1·8%)	6089 (1·6%)	2405 (2·9%)	..	..	..
Cases (all forms)	2416 (100%)	603 (25%)	273 (11%)	1020 (42%)	520 (22%)	..
Annual percent increase (2010–2011)	277%	NA	NA	286%	39%	..
Median (range) age of cases (years)	25·1 (0·1–105·0)	29·8 (0·8–90·3)	25·0 (0·8–74·0)	25·0 (0·1–105·0)	23·0 (0·6–86·0)	<0·0001†
Female	1336 (55%)	311 (52%)	117 (43%)	583 (57%)	325 (62%)	<0·0001
Previously treated	539 (22%)	170 (28%)	85 (31%)	216 (21%)	68 (13%)	<0·0001
Pulmonary	1781 (74%)	536 (89%)	228 (84%)	745 (73%)	272 (52%)	<0·0001
Smear positive, adult	846 (35%)	237 (39%)	119 (44%)	363 (36%)	127 (24%)	<0·0001
Smear negative, adult‡	730 (30%)	255 (42%)	80 (29%)	302 (30%)	93 (18%)	<0·0001
Smear positive, child	42 (2%)	9 (1%)	11 (4%)	12 (1%)	10 (2%)	0·014
Smear negative, child	163 (7%)	35 (6%)	18 (7%)	68 (7%)	42 (8%)	0·506
Extrapulmonary	635 (26%)	67 (11%)	45 (16%)	275 (27%)	248 (48%)	<0·0001
Adult	498 (21%)	53 (9%)	30 (11%)	232 (23%)	183 (35%)	<0·0001
Child	137 (6%)	14 (2%)	15 (5%)	43 (4%)	65 (12%)	<0·0001

Data are number of individuals (N) or N (%), unless otherwise stated. NA=not available. *χ^2 test for homogeneity of proportions. If p<0·05, the characteristic proportion (eg, sex) is different in at least one of the case-detection settings. †p value for age is from one-way ANOVA. ‡Includes eight patients who had positive GeneXpert assay results: five from Indus Hospital's outpatient department and three from family clinics.

***Table:* Characteristics of 2416 tuberculosis cases identified through screening and referrals**

Results

Between Jan 3, 2011, and Dec 31, 2011, screeners assessed 388 196 individuals at 54 family clinics and identified 6089 people they suspected to have tuberculosis. Screeners also vetted 81 700 people at the Indus Hospital's outpatient department and identified an additional 2405 (figure 1). These 8494 patients yielded 876 with tuberculosis; 603 were from family clinics and 273 from the outpatient department. Indus Hospital's tuberculosis clinic reported 1020 cases from self-referrals and 520 through referrals. The table gives characteristics of the 2416 patients with tuberculosis identified.

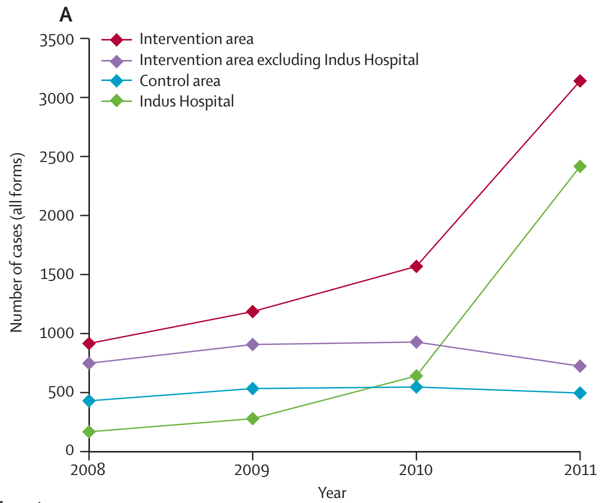
Compared with 2010, in 2011 Indus Hospital notified 3·77 times more tuberculosis cases of all forms (641 *vs* 2416 patients); notification of adult pulmonary tuberculosis increased by 3·77 times (415 *vs* 1576) and childhood pulmonary tuberculosis by 7·32 times (28 *vs* 205). Overall in the intervention area, the number of tuberculosis notifications increased by 2·0 times from 2010 to 2011, from 1569 to 3140 cases. This was a 2·21 times increase (95% CI 1·93–2·53; p=0·000) relative to the change in the control area, where the number decreased by 9%, from 547 to 496 (figure 2A). From 2010 to 2011, case-notification rates increased by 1·94 times in the intervention area (from 176 to 343 per 100 000), and decreased by 12% in the control area (from 46 to 41 per 100 000; figure 2B).

During the 3 years before the intervention (2008–10), case notifications in the intervention area (including Indus Hospital) increased by an average of 1·07 times every quarter, and notifications at Indus Hospital alone increased by an average of 1·20 times (figure 3). There was no detectable change in case notifications from the other seven NTP reporting centres in the intervention area or from NTP centres in the control area (p=0·163).

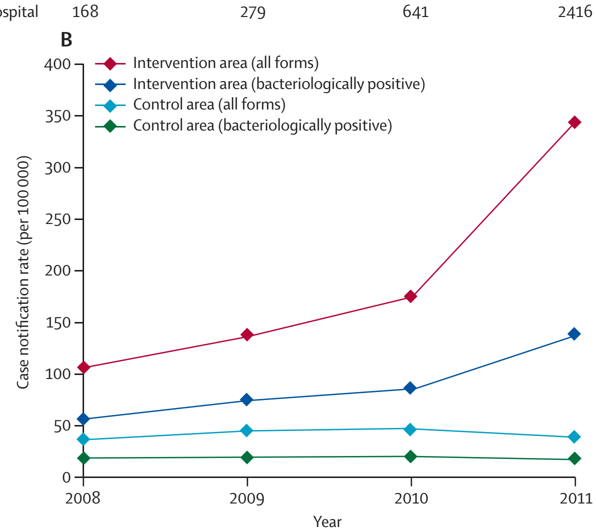
Throughout 2011, the number of case notifications from Indus Hospital increased by an average of 1·44 times every quarter, a rate 1·2 times higher than before the intervention. For the intervention area as a whole, the number of case notifications increased by an average of 1·22 times each quarter in 2011, a rate 1·14 times higher than before the intervention. There was no significant change in case notifications from NTP centres in the control area before and after the intervention. Excluding Indus Hospital, case notifications from NTP reporting centres in the intervention area decreased by an average of 0·89 times each quarter after the intervention.

Primary default rates between diagnosis and treatment initiation were very similar at the outpatient department (13 of 286 [4·5%]) and family clinics (28 of 631 [4·4%]). Among 75 patients with smear-positive pulmonary tuberculosis who have completed the 8 month treatment regimen at family clinics, 60 (80%) were successfully treated, 13 (17%) defaulted, one (1%) died, and treatment failed in one (1%). Among 183 such patients at Indus Hospital, 114 (62%) were successfully treated, 17 (9%) were transferred out to an NTP centre closer to home, treatment failed in 18 (10%), 29 (16%) defaulted, and five (3%) died.

Figure 4 shows the location of participating family clinics and NTP reporting centres. For every self-referral to Indus Hospital from outside the intervention area, there were 13·1 self-referrals from within the intervention area.

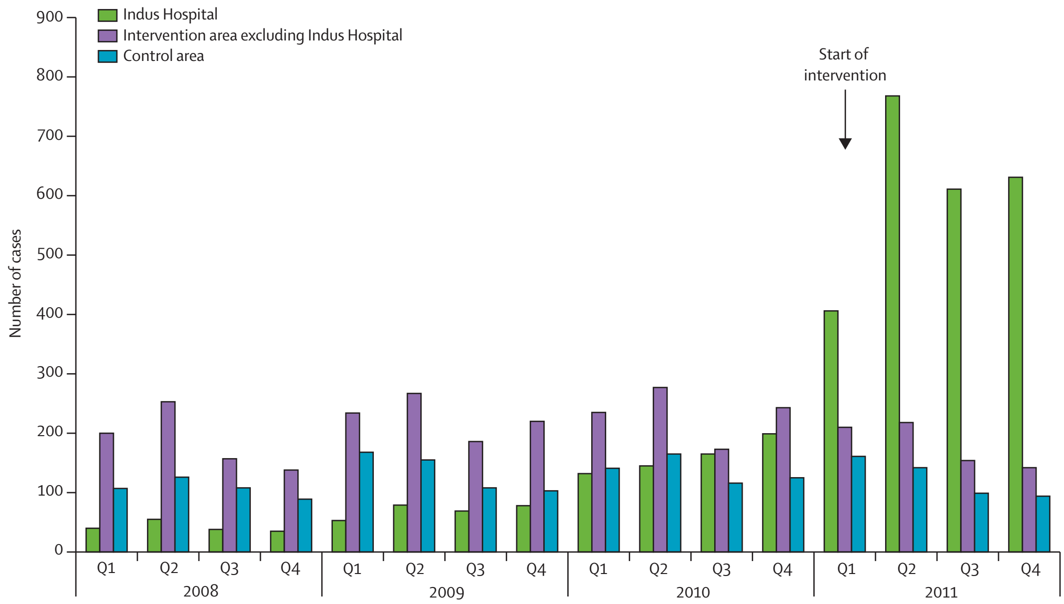


	2008	2009	2010	2011
Number of cases (all forms)				
Intervention area	916	1186	1569	3140
Intervention area excluding Indus Hospital	748	907	928	724
Control area	430	534	547	496
Indus Hospital	168	279	641	2416



	2008	2009	2010	2011
Intervention area population	838 057	863 199	889 095	915 767
Intervention area cases (all forms)	916	1186	1569	3140
Intervention area rate (all forms)	109	137	176	343
Intervention area cases (bacteriologically positive)	491	652	771	1266
Intervention area rate (bacteriologically positive)	59	76	87	138
Control area population	1 110 274	1 143 582	1 177 890	1 213 226
Control area cases (all forms)	430	534	547	496
Control area rate (all forms)	39	47	46	41
Control area cases (bacteriologically positive)	208	246	255	208
Control area rate (bacteriologically positive)	19	22	22	17

Figure 2: **Tuberculosis case notification (A) and case-notification rates (B) to the national tuberculosis programme, for 2008–11**



	2008 Q1	2008 Q2	2008 Q3	2008 Q4	2009 Q1	2009 Q2	2009 Q3	2009 Q4	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4
Indus Hospital	40	55	38	35	53	79	69	78	132	145	165	199	406	768	611	631
Intervention area excluding Indus Hospital	200	253	157	138	234	267	186	220	235	277	173	243	210	218	154	142
Control area	107	126	108	89	168	155	108	103	141	165	116	125	161	142	99	94

Figure 3: **Quarterly tuberculosis case notifications by Indus Hospital, all other national tuberculosis programme reporting centres in the intervention area, and the control area, for 2008–11**

We spent $10 638 on the communication campaign during the intervention year, including $3118 on billboards at road intersections, $1671 on signboards outside family clinics, $1529 on posters and pamphlets distributed through the clinics, and $847 on local cable network advertisements. Between October and December, 2011, 283 (22%) of 1310 self-referrals surveyed identified direct advertising as their motivation for visiting Indus Hospital.

We accepted 160 applications for the role of screener, invited 120 people for interviews, and short-listed 75 for the introductory session, of which 55 expressed an interest. After training and assessment, 42 people were confirmed as screeners. Screeners had at least 10 years of school education, although only 16 (38%) had previous work experience, often as clinic or shop assistants. Their median age was 24 years (range 18–50) and six (14%) were women. We paid $23 478 in total as incentives and stipends to screeners, for a median monthly income of $50 (range $25–279). Highly rewarded screeners showed good interpersonal skills and had independently established local referral networks from a few family clinics not assigned to them or to other screeners.

Discussion

By use of incentive-driven mobile-phone-based mass screening by community laypeople at family clinics, and a mass campaign encouraging self-referral to private facilities, we noted that, in 2011 compared with 2010, the number of case notifications doubled in the intervention area and fell slightly in the control area. We also noted a nearly four-times increase in adult pulmonary tuberculosis cases and more than seven-times increase in paediatric cases at Indus Hospital in 2011 compared with 2010. 6 months after the start of the intervention, Indus Hospital became the second highest NTP reporting centre in Pakistan.

Over a third of the cases notified by Indus Hospital were identified through systematic screening of waiting rooms at family clinics and the hospital's outpatient department. Without this screening effort, few or none of these patients would have been detected, notified, and placed on standard treatment, and substantial delays in diagnosis would have been likely.[15] Hospitals are well documented as sites where patients with tuberculosis unwittingly expose health workers and other patients to infection.[24–26] Screening patients for productive cough at hospital outpatient departments should be standard in regions with a high burden of disease, even if screening does not identify all pulmonary tuberculosis cases.[27,28]

Of the 2416 cases of tuberculosis identified during the intervention, the largest group (1020 [42%]) were self-referrals to the Indus Hospital tuberculosis clinic. The number of self-referrals with pulmonary tuberculosis was more than three-times higher in 2011 than 2010, which is at least partly due to the billboard and cable television advertisements promoting Indus Hospital's services. The hospital's free high-quality services and its accessibility by public transport make it an attractive

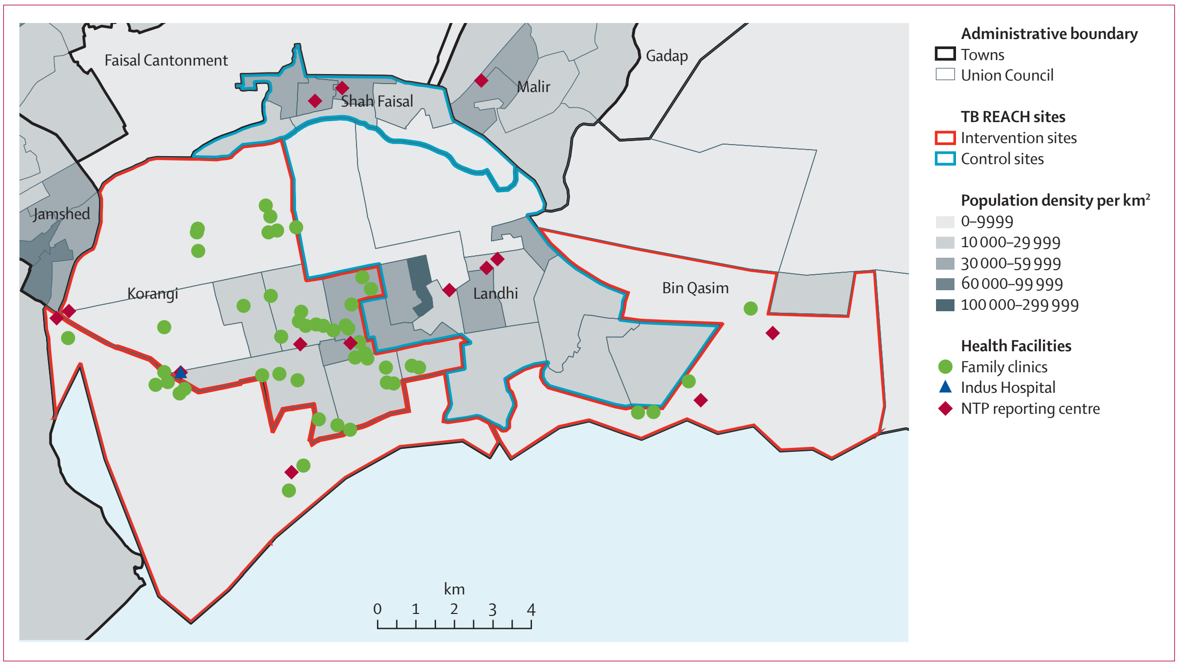


Figure 4: **Map showing intervention and control area boundaries, and location of clinics and NTP reporting centres**
NTP=national tuberculosis programme.

option for patients. Most of the self-referrals were residents of the intervention area, and similar increases in case notification due to self-referrals were not seen at other NTP reporting centres in the intervention or control areas. Although it is difficult to directly attribute this increase to the mass communication campaigns, the combination of targeted messaging and word-of-mouth observations resulting from screening more than 450 000 people at family clinics and the outpatient department probably increased self-referrals in the intervention area.

Around a fifth of the cases identified during the intervention period at the tuberculosis clinic were referrals from other clinics or from inpatient services at Indus Hospital; of these 520 patients, 426 (82%) had visited the outpatient department where screeners were active, suggesting significant room for improvement in the sensitivity of the screening questions.

The seven-times increase in childhood tuberculosis cases presented both an opportunity and a logistical challenge. We did not anticipate this scale of increase, which potentially highlights the underestimation of childhood tuberculosis worldwide. Additionally, the increase in smear-negative adults with suspected tuberculosis stretched radiology resources at Indus Hospital and resulted in diagnostic delays, or worse, many patients not being diagnosed because of their inability to visit Indus Hospital. Mobile radiograph facilities closer to the family clinics where screening was taking place could have mitigated these issues. Challenges resulting from potentially rapid increases in cases and workload, and the need for enhanced supply-chain management of diagnostics and drugs, will need to be addressed to maintain high rates of treatment success.

Our intervention had several limitations. Because several components were implemented simultaneously, we are unable to determine which one contributed most to the observed effect, and whether any one of the components in isolation would have had a substantial effect. The intervention took place in a single population of 0·9 million people in 1 year, and might reflect a so-called mopping up of prevalent cases, but this probably does not fully explain the increase in case notifications. The number of smear-negative, radiograph-suggestive cases identified by family doctors was high. All radiographs were read by a single radiologist, and specialists at Indus Hospital clinically verified all patients, unless the patient declined to go there or a family doctor disagreed with the study radiologist's report. We cannot anticipate how long this substantial increase in case detection will be sustained, and whether similar increases might be seen in areas without the central role of a respected and free-of-cost institution like Indus Hospital. We did not formally evaluate doctor and patient perception of screeners and monitors, although the general feedback was positive. Treatment outcomes were not ideal for cases notified in the first 3 months at the Indus Hospital, mainly because of high transfer out and treatment failure rates. Treatment outcomes will probably improve in subsequent months with retrospectively added interventions to minimise default rates. All patients failing treatment are referred to the drug-resistant tuberculosis programme at Indus Hospital. The inclusion of a few patients from areas adjacent to the intervention area, including the control area, in the overall case notifications by Indus Hospital led to a slight overestimation of the intervention's effect; but the observed decrease in case notifications in the control area (for 2011 relative to the previous 3 years) was not significant. Many patients will need continued treatment through family clinics beyond the end of the case-detection intervention. Resources for providing treatment services will need to be identified from the existing grant and through additional sources. These limitations should be addressed in future studies, but our findings highlight significant gaps in tuberculosis case detection in Karachi.

Engagement of community members as drivers of case detection, and intermediaries such as Indus Hospital as facilitators, can create highly productive links between the public sector, private practitioners, and communities. In this study, family doctors enthusiastically adopted standard-of-care practices for tuberculosis case detection and treatment. With free access for their patients to diagnosis and treatment facilities through NTP partners, family practices can be a force for social change. Our study emphasises the benefits of using several interlinked innovations—such as mobile-phone-based screening by community members, conditional cash incentives, and mass communication campaigns—as effective ways of identifying patients with tuberculosis, helping to reduce transmission and mortality and progress toward tuberculosis elimination. This study also provides an example for addressing other infectious and non-communicable diseases through the private sector.

Contributors

AJK, SKh, IL, SM, MCB, and SKe were responsible for study design. AJK, SKe, JC, MCB, and HH contributed to the literature search, monitoring study progress, data analysis, figures, and manuscript writing. SKh, FSK, FQ, and SM were responsible for data collection at family clinics and the Indus Hospital outpatient department. UK and FA were responsible for clinical and programmatic data collection at the Indus Hospital tuberculosis clinic. AH was responsible for design and implementation of the mobile phone data-collection system. IL contributed to data analysis. All authors interpreted the data and reviewed the manuscript.

Conflicts of interest

JC is a member of the TB REACH secretariat, but was not involved in the study design or the decision to fund the project. All other authors declared that they have no conflicts of interest.

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