Occupational Pulmonary Tuberculosis among BRAC Community Health Workers of Trishal, Bangladesh

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GLOSSARY

BCG	Bacille Calmette and Guerin
CXR	Chest X-ray
DOTS	Directly Observed Treatment, Short Course
EQA	External Quality Assurance
HIC	High-income Country
HW	Health Worker
IUATLD	International Union Against Tuberculosis and Lung Diseases
LIC	Low-income Country
LMIC	Low and Middle-income Country
MDR-TB	Multi-drug Resistant TB
NTP	National TB Control Programme
PO	Programme Organizer
PTB	Pulmonary Tuberculosis
SK	*Shasthya Karmi*
SS	*Shasthya Shebika*
TB	Tuberculosis
UHC	*Upazila* Health Complex

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ABSTRACT

Different studies reported 2-14 times higher risk of TB for the healthcare workers than the general populations. This poses a serious challenge to the healthcare workers involved in TB control worldwide. BRAC has been using services of thousands of community-based health workers (CHW) known as *shasthya shebikas* for TB control all over the country. Their continuous exposure to infectious pulmonary TB (PTB) patients might have increased the risk of disease transmission. This concern led RED to implement a pilot study in Trishal *upazila* to (i) assess the operational feasibility of using CXR (chest X-ray) as a tool for PTB diagnosis, and obtaining and testing sputum samples; and (ii) measure the rate of active TB in different health workers of BRAC. Data were generated through face-to-face interview using structured and semi-structured instruments. Each eligible CHW gave a CXR at a designated private clinic at Trishal. Three independent specialist physicians examined the CXRs. Besides, three sputum samples (night, morning and spot) were collected from each of the study participants, and tested at BRAC field laboratories. Five percent of them were re-tested at an external quality assurance laboratory in Mymensingh for quality control. Additional sputum samples of 26 respondents (two from each) were cultured at the national TB programme reference laboratory in Dhaka. Positive agreement of two examiners on an individual CXR or two sputum slides test-positive or one sputum slide test-positive supported by one CXR-positive or one sputum culture-positive was defined as a TB patient. Quantitative data were analyzed by SPSS software, while the qualitative data were handled manually. The estimated prevalence rate of smear-negative PTB among the *shasthya shebikas* was 1,612.9/100,000. This was 4-fold higher than the prevalence of all forms of TB in the general population of Bangladesh. This implies that the grassroots health workers are at a greater risk of PTB. Qualitative explorations revealed that contact with PTB patients and poverty were major causes of PTB among SSs, warranting appropriate measures for preventing disease transmission.

EXECUTIVE SUMMARY

Introduction

For over 25 years, BRAC has provided community-based tuberculosis (TB) control services through its cadre of village women trained as health volunteers. Their close and continuous contact may heighten their individual risk of transmission of pulmonary TB (PTB). This concern led the BRAC Research and Evaluation Division to implement a pilot study in Trishal *upazila* (sub-district) in Mymensingh to (i) assess the operational feasibility of using chest x-ray (CXR) as a tool for TB diagnosis in the community, and obtaining and testing sputum samples from health workers (HW); (ii) measure the rate of active Mycobacterium tuberculosis in different frontline HWs of BRAC in Trishal; and (iii) explore food habits and annual food security of the HWs who would be identified as TB cases and compare with a sub-sample of HWs without TB.

Methods and materials

Trishal was randomly selected from among the 10 oldest *upazilas* of BRAC where the TB programme was initiated in 1992. The *upazila* has approximately 751 active healthcare providers (659 *shasthya shebikas* or SSs, 73 *shasthya kormis* or SKs, 2 lab technicians, 16 programme organisers, and 1 *upazila* manager). The study could cover 94.4% of all. Table A shows different types of HWs by major activities related to TB control in Trishal *upazila*.

Table A. Different types of HWs by major activities related to TB control in Trishal *upazila*

Designation	Number	Major activities
Shasthya shebika	659	TB case finding; DOT initiation; patient follow-up; and sputum sample collection.
Lab technician	2	Sputum microscopy; and smearing supervision.
Shasthya Kormi	73	SSs' activity supervision; and patient follow-up.
Programme organizer (health)	16	Sputum smearing; supervision; and patient follow-up.
Upazila manager	1	Overall supervision of TB control activities.

Face-to-face interview using pre-tested structured and semi-structured schedules generated data on the background variables including TB symptoms and prolonged cough for minimum 3 weeks. Data on the status of active TB (outcome variable) came from chest X-ray (CXR) or sputum test or culture. In the first step, two independent experts examined all the CXR films (673) (584 SSs, 70 SKs, 16 POs, 2 lab technicians, and 1 *upazila* manager). Both of them confirmed 612 (90.9%) CXRs were normal. The remaining 61 films were read by a third expert. Ten cases (all SSs) were confirmed having PTB by at least two of the expert readers, while 16 were suspected for PTB by one expert and 35 were labelled as normal.

Of the 709 health workers interviewed, 679 (95.8%) gave sputum samples (3 each) for testing. The collected sputum samples were tested for Acid-Fast-Bacilli at two BRAC's field laboratories. Five percent of the samples tested at field laboratories were randomly drawn and re-tested for quality control at the External Quality Assurance laboratory of the National Tuberculosis Programme (NTP) in Mymensingh. For further confirmation, we collected two additional sputum samples (morning and spot) from each of the 26 HWs (10 PTB-positive and 16 CXR-suspects) as determined by CXR for culture at the NTP Reference Laboratory in Dhaka. Using the conventional TB culture on Lowenstein-Jensen medium the sputum samples were cultured.

Using a semi-structured questionnaire, additional data were collected on food habits and food security of the 10 CXR PTB-positive but smear-negative PTB patients and 10 randomly selected non-TB cases from among the study samples to reveal a comparative scenario. They were also asked open-ended questions about the perceived causes of TB. Based on the results of CXR and sputum testing and culture, PTB cases were defined. A study health worker was defined as a PTB case, if s/he fulfilled any of the following conditions: (1) Positive agreement of two examiners on an individual CXR alone; (2) Two sputum slides test-positive of an individual alone; (3) One sputum slide test-positive supported by at least one PTB-positive confirmed by an expert reader through CXR reading, otherwise was defined as non-PTB case; and (4) One/two sputum culture-positive was also defined as a TB case.

The rates of PTB-positive by CXR but smear-negative PTB among the health workers were computed to compare with that of the national prevalence rate of all forms of TB among the general population aged 15 years and above. Categorical and numeric data from the additional semi-structured interviews (with 10 smear-negative PTB patients and 10 non-TB cases) were managed and analysed in SPSS software. Narrative data from the open-ended questions were transcribed verbatim in local language Bangla, translated into English and managed and analysed manually. The analysis identified perceived cause-related themes/sub-themes from the respondents' narratives. In an attempt, the features, and distinctive aspects of causes of TB reported by both TB patients (HWs with PTB) and non-TB cases (HWs without PTB) were assessed and summarised in matrix for presentation and interpretations.

Main results

Smear-negative PTB prevalence among health workers

Of the total 673 CXR provider-participants of different types, smear-negative PTB (measured by CXR) was confirmed by at least two expert CXR examiners in 10 participants, and all of them were *shasthya shebikas* (SS). Thus, the estimated prevalence rate of smear-negative PTB was 1,612.9 per 100,000 SSs at Trishal *upazila* (10/620*100,000).

Operational feasibility of taking CXR at community

The X-ray machine at the government *upazila* health complex was found to be dysfunctional, but several private clinics equipped with X-ray facility were available and assessed for performing CXR. The POs were oriented on the needs for and process of CXR and given responsibility to bring all SSs under their supervisory areas for CXRs on scheduled dates. The research project bore all the expenses including transportation and meals. Ninety five percent of the study HWs attended for CXR, and the remaining were either suffered from contraindications or were absent from homes.

A comparative scenario of smear-negative PTB patients (HWs with PTB) and non-TB cases (HWs without PTB) in some important indicators

Incidence of failure in eating three full meals a day in last 12 months (for 1 or more days per month) was higher for the non-TB cases than the TB patients (70 vs. 50%). More TB patients than non-TB cases could not cook meat in last 12 months (80 vs. 60%). More non-TB cases than TB patients could not afford milk for most times (40 vs. 30%). Likewise, more non-TB cases compared with the TB patients failed in most times to eat seasonal fruits (50 vs. 30%). In essence, the mean days of deprivation in the consumption of different food items in last 3 months were more or less similar for both TB patients and non-TB cases (ranging from 2-28 days for the TB patients, and 3-28 days for the non-TB cases).

Similarities and dissimilarities in certain characteristics of TB patients and non-TB cases

PTB patients were more likely to be underweight than non-TB cases measured by body mass index (BMI) (70 vs. 40%). The median length of work of TB patients as TB service provider was higher than the non-TB cases (36 vs. 19 months). One-fifth of TB patients and less than one-third (30%) of non-TB cases were deficit in annual income compared to the needs. There was no correlation between TB status and frequency of daily interactions with PTB patients or family history of TB. The proportion wearing a mask during interactions with PTB patients was reported to be higher for TB patients than non-TB cases (80 vs. 30%; $p<0.05$).

Perceived causes of PTB

Both TB patients and non-TB cases frequently reported contact, poverty, hazardous living conditions, heredity, cleanlilessness, hazardous working place, smoking, mental depression and cold/untimely bathing as perceived causes of TB. TB patients more frequently than non-TB cases reported contact with individuals with active TB as a factor of their having TB. Many respondents in both groups believed that activities such as caring/nursing and observing daily treatment for TB patients put them at risk for TB. A PTB patient said:

> *I nursed about 16 TB patients and fed them medicine [or medications]. They used my glass while taking medicine [or medications], and I drank water with that glass. They talked to me open mouthed without any cover. They often coughed up and spit sputum here and there. Thus, TB germs infected me. Despite my earnest request, the programme's TB patients never covered their mouths during interactions.*

Economic hardships arising from poverty often compelled the respondents to eat less. They typically referred to lack or shortage of foods vis-à-vis intake of poor nutritious food disrupted the immune systems causing TB. "Insufficient food intake dries up [one's] stomach, resulting in a weak immune system. And the disease occurs in a weak body," commented a TB patient.

Conclusion

This pilot study provides supportive evidence that SSs have an increased risk of having occupational TB.

Recommendations

(1) An expanded study may be instituted to draw samples from a wider number of *upazilas* under the purview of BRAC TB control programme to evaluate the prevalence of PTB among BRAC HWs;

(2) Routine annual check-ups for health workers may be developed and implemented for early diagnosis of infections. Other recommended activities include:

   (i) Tracking case history for each health worker

   (ii) Ensuring that all HWs reporting symptoms receive prompt diagnosis and referrals as required

(3) SS should be trained and supported in asking patients to bring their own glass for drinking water in DOT sessions; and

(4) Personal and administrative measures for controlling occupational transmission of TB should be rigorously implemented (Table 1).

BACKGROUND

Over one-third of the global population are infected with *Mycobacterium* tuberculosis (WHO 2008), and they may turn into active tuberculosis (TB) cases at any time of their life cycle. In activities related to controlling TB, many healthcare workers come into contact with the disease. In the pre-antibiotic era (before 1944), TB caused substantial morbidity and mortality among medical and nursing students (Sepkowitz 1994). With the advent of effective antibiotic therapy and decreasing incidence in high-income countries (HIC), the TB risk declined, leading to complacency about nosocomial[1] transmission of TB (Menzies *et al.* 2007). In late 1980s, dramatic nosocomial outbreaks of multidrug-resistant (MDR) TB occurred, largely in populations infected with the human immunodeficiency virus (HIV). These outbreaks stimulated substantial investment in administrative, personal and engineering infections control measures (Table 1) in many hospitals in the HICs, leading to successful reductions in transmission (Wenger *et al.* 1995, Maloney *et al.* 1995, Fella *et al.* 1995, Blumberg *et al.* 1995). The United States' Centres for Diseases Control and Prevention (1994) reported a 3.2-fold increase in risk of TB for healthcare workers compared to the general population.

In the low- and middle-income countries (LMIC), the risk of TB among health workers (HW) has received relatively limited scrutiny. Few studies have documented prevalence or incidence of nosocomial TB infection and/or disease in different settings and all these have been published since 1990. Although the International Union Against Tuberculosis and Lung Disease (the Union) and the World Health Organization (WHO) issued recommendations for infection control within health facilities (IUATLD and WHO 1994), implementation of many of the recommended practices, such as engineering controls, are precluded by resource constraints (Table 1). There is thus considerable interest in finding simple yet effective measures to prevent nosocomial transmission of TB in those settings.

[1] Nosocomial TB refers to an occurrence, usually acquisition of an infection, in a healthcare setting or as a result of medical care (WHO 1999).

Table 1. Measures for controlling nosocomial transmission of TB

Administrative	Personal	Engineering
1. Priority to patients with chronic cough in OPD 2. Rapid sputum collection, transport and reporting 3. Limitations on number of visitors 4. CXR at quiet times in the day 5. TB patients spend more daytime outdoors when possible 6. Early suspicion of TB 7. Early initiation of treatment 8. Isolation of patients with TB 9. One-stop OPD services	1. Proper cough hygiene 2. Mask worn by TB patients when undergoing surgical procedures 3. N 95 mask use by HWs 4. HEPA filter in laboratory areas	1. Increased natural ventilations 2. Windows left open most of the time 3. TB isolation room in wards 4. Class II safety cabinets in laboratory 5. UV germicidal irradiation system in laboratory

TB=tuberculosis; OPD=out-patient department; CXR=chest X-ray; HW=health worker; UV=ultraviolet. HEPA=high efficiency particulate air. Source: Adapted from D. Menzies *et al.* 2007.

Bangladesh is ranked 6th among the 22 "high TB burden" countries, which account for 80% of the world's TB (WHO 2008). Over a half of the Bangladesh population are infected with M. tuberculosis (MTB), and the annual risk of TB infections (ARTI) is estimated to be 2.3% (Weyer 1997). The country has an annual incidence of 101 per 100,000 population (WHO 2008). The government of Bangladesh (GoB), in partnership with a host of non-governmental organisations (NGO), including BRAC, implements DOTS (directly observed treatment, short course) to control TB.

BRAC TB Control Programme (BTP)

The primary providers in BRAC's community-based DOTS model are the female volunteers known as *shasthya shebikas* (SS). They work under the direct supervision of *shasthya kormis* or SKs (paid health worker), para-professionals and physicians. The *upazila* level staffs are supervised by the Regional Sector Specialists (Health), and they are in turn accountable to TB Control Programme Head based at the Head Office, while the programme head is reportable to the Director of BRAC Health Programme (Fig.1).

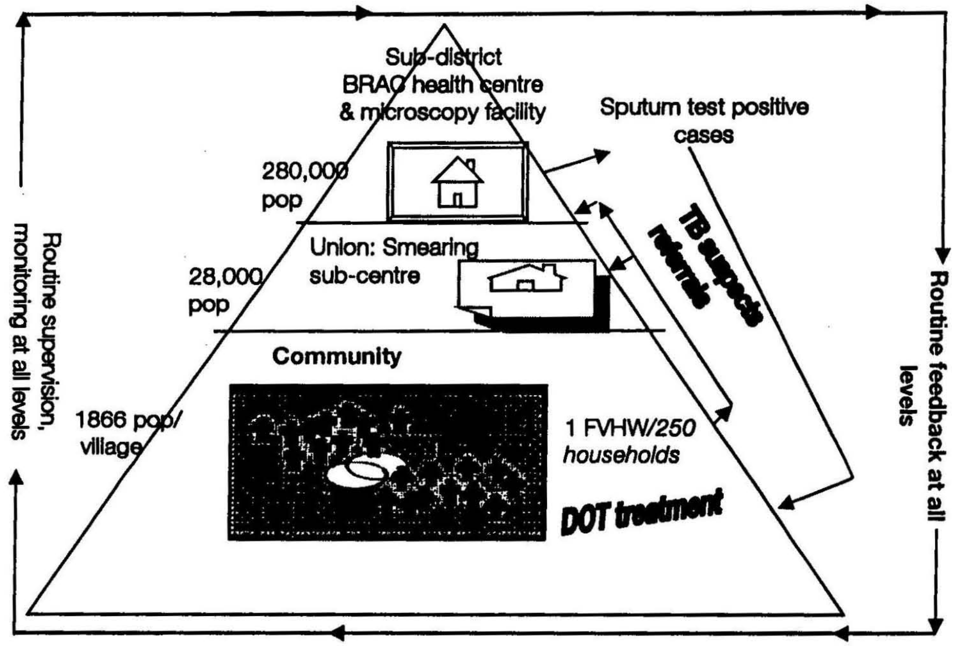
The SSs maintain a semi-active case finding strategy, and they mobilise the community people during their routine home visits, search for TB suspects (persons with prolonged cough for at least three weeks), and refer them to either BRAC union level sputum collection sub-centre, which operates once a month, or sub-district microscopy facilities for sputum testing, which operates 6 days a week, depending on the patients' preferences and location. Testing services are provided at no cost. SS are notified about patient diagnosis and relay the information to them directly.

Treatment initiation

Prior to treatment commencement, a smear-positive patient deposits Taka 200 (USD 3) and signs a bond, guaranteeing adherence to the full course of treatment.

Following the successful completion of treatment, BRAC returns the amount to the patient. Patients that fail to complete treatment for non-medical reasons forfeit their bond. However, the extreme poor are exempted from depositing money, and all diagnosed cases are put on treatment immediately. Patients visit the SS's home daily during the initial 2-3 months for directly observed therapy. Subsequently, patients collect medicines once a week from the SSs' homes, and the SSs ensure follow-up over the full course of treatment.

Figure 1. Operational procedures of BRAC community-based DOTS



Note: Estimated populations; FVHW = Female Volunteer Health Worker. Source: Karim F (2009)

The government role

The NTP provides all medications and laboratory supplies for TB control. BRAC's programme largely relies on the microscopy centres at union- or *upazila*-level health facilities for diagnostics. In many cases, BRAC staff work within government laboratories or in laboratories that BRAC establishes on land owned by the government. Patients with side effects or complications are referred to public sector facilities. The NTP also monitors programme performance and quality.

The challenges to TB control workers

Frontline workers are exposed to the infectious pulmonary TB (PTB) cases during case finding, DOT initaition and patient follow-up in their catchment areas.The frequency of these activities increases their susceptibility to contracting the disease relative to BRAC's other field staff. The laboratory technicians are at an increased risk of acquring TB infections since they directly handle the sputum samples of the TB suspects at laboratories. The SKs and POs are also exposed to the risk of active TB cases during their supervisory and monitoring works (Table 2).

Table 2. Different types of HWs by major activities related to TB control in Trishal *upazila*

Designation	Number	Major activities
Shasthya shebika	659	TB case finding; DOT initiation; patient follow-up; and sputum sample collection.
Lab technician	2	Sputum microscopy; and smearing supervision.
Shasthya kormi	73	SSs' activity supervision; and patient follow-up.
Programme organizer (health)	16	Sputum smearing; supervision; and patient follow-up.
Upazila manager	1	Overall supervision of TB control activities.

The community setting provides some natural control such as open ventilation in general and sunlight, but other important measures of infection control, such as utilization of masks by both patients and providers, are infrequent due to issues of cost and stigma. We believe that these conditions create risks for community-based providers and other staff involved in the TB programme at the local level.

THE STUDY

Given the situation, BRAC Research and Evaluation Division conceived a representative study on the transmssion of TB to health workers involved in TB control service delivery. But to identify the level of occupationally transmission of TB, application of multiple diagnostics is essential, where a single most effective modern diagnostic is unavailable, nor feasible to apply for reaping effective outcomes of the study. Thus, before going for a larger study, using accessible multiple diagnostics we implemented a pilot study in Trishal sub-district of Mymensingh, situated to the north of Dhaka capital city. This report documents the results and expereinces of the pilot study.

Objectives

The three-fold objectives of this pilot study were to:

(i) assess the operational feasibility of using chest x-ray (CXR) as a tool for PTB diagnosis, and obtaining and testing sputum samples from healthcare workers;

(ii) measure the rate of active *Mycobacterium* tuberculosis in different cadres of frontline health workers of *BRAC in Trish*al *upazila*; and

(iii) explore food habits and annual food security of the HWs who would be identified as PTB patients and compare with a sub-sample of HWs without PTB.

METHODS AND MATERIALS

Research type

A cross-sectional study implemented on an experimental basis in Trishal *upazila* of Bangladesh.

Research area

We chose to conduct the study in a randomly selected *upazila* (Trishal) of the 10 *upazilas* where the BRAC community-based DOTS strategy had been operational from early 1990s. The age of health workers and duration of exposure could increase the risk of contracting TB (Menzies *et al.* 2007 and Pai *et al.* 2005). Trishal *upazila* has approximately 751 active healthcare providers (659 SSs, 73 SKs, 2 lab technicians, 16 POs, and 1 *upazila* manager).

Trishal is one of the densely populated *upazilas* in the country with over 441,248 population (male 222,886 and female 218,362). The population density is high with over 1,099 people per sq.km, higher than the national average of 979 (BBS 2008). Most people (57.3) are aged over 15 (male 127,582 and female 125,349). Twenty three percent of the people are engaged in agricultural activities for livelihood, and 40% of the people are literate. Over 94% people live in *jhupri* (a low hut built with tree leaves) or *kuncha* dwelling houses with poor sanitation conditions—23% of the households have sanitary latrines.

No specific smear-positive PTB prevalence data is available for Trishal. Service statistics of the routine TB control programme of BRAC for the period from August 2009 to July 2010 reveal a prevalence of 229 per 100,000 of adults of 15 years and above. Of them, the rate of new smear-positive is 125.6/100,000 and others 76.7/100,000.

Sample size

As noted, there are about 751 different types of health workers engaged in BRAC TB control service delivery in the *upazila*. All of them were planned to include in the study.

Variables

Demographic

Age, sex, marital status, HH members, etc.

Socioeconomic

Occupation, education, religion, length of profession, food habits, perceived food security, dwelling house conditions, water and sanitation sources, etc.

Health

BCG scar, different substance use, other risk factors for TB, history of TB in the household including its treatment and adherence, general symptoms of TB, prolonged cough for minimum 3 weeks, measures taken, diagnosis and 3 sputum samples (night, morning and spot), practice of nosocomial transmission control measures (e.g., wearing mask) at work place, chest x-ray (CXR), and height and weight (BMI)[2].

Data collection techniques and tools

Face-to-face interview using pre-tested schedules generated data on the background variables, including TB symptoms and prolonged cough, food habits, and food security. Data on the status of active PTB (outcome variable) came from CXR or sputum test or culture.

Chest x-ray (CXR)

The study HWs were asked to give a CXR at a private diagnostic clinic located in Trishal. An agreement with the x-ray clinic was made and the responsible technicians were given a short orientation on the purpose of the study and importance of quality CXR in the diagnosis of TB. Severely sick and pregnant HWs were excluded from taking CXRs.

CXR examination for case identification

Two independent experts initially examined all the CXR films (673). Both of them confirmed 612 (90.9%) CXRs were normal, and 10 with PTB conditions. The remaining 51 films were read by a third expert, and 35 were confirmed as normal, while 16 were reported as PTB suspects.

Sputum samples for microscopy

Each study HW was requested to give 3 samples of sputum, one at night, one in the early morning, and one on the spot. Of the 709 HWs interviewed, 679 (95.8%) gave sputum samples (3 each) for testing. The collected sputum samples were tested at two BRAC field laboratories located in the study *upazila* for Acid-Fast-Bacilli. Required quantity of sputum was used for performing Ziehl-Neelsen staining. Stained smear was tested under microscope in oil immersion. Five percent of the samples

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[2] BMI=Body mass index. Calculation formula: Weight in kilograms/Height in meters^2. Under weight=<18.5, Normal weight=18.5-24.9.

tested at field laboratories were randomly drawn and re-tested at the NTP External Quality Assurance (EQA) laboratory at Mymensingh for quality control.

Sputum culture

For further confirmation, we collected two additional sputum samples (morning and spot) from each of the 26 (10 PTB-positive and 16 PTB suspects as determined by CXR) for culture at the NTP Reference Laboratory in Dhaka. Using the conventional TB culture on Lowenstein-Jensen medium, the sputum samples were cultured.

Additional data collection and analysis

Using a semi-structured questionnaire, data were collected on food habits, and food security of the 10 smear-negative PTB patients (HWs with PTB) and 10 randomly selected non-TB cases (HWs without PTB) from among the study samples. To explore possible causes of TB, each of them were also asked a series of open-ended questions on the perceived causes of TB.

Data management

The background data were edited, coded, entered in computer, and checked for consistency and cleaned using SPSS software version 14. Based on the results of CXR and sputum testing and culture, PTB cases were defined. A study HW was defined as a PTB case, if s/he fulfilled any of the following conditions:

(1) Positive agreement of two examiners on an individual CXR alone.

(2) Two sputum slides test-positive of an individual alone.

(3) One sputum slide test-positive supported by at least one CXR study positive (confirmed by an expert reader), otherwise was defined as non-PTB cases.

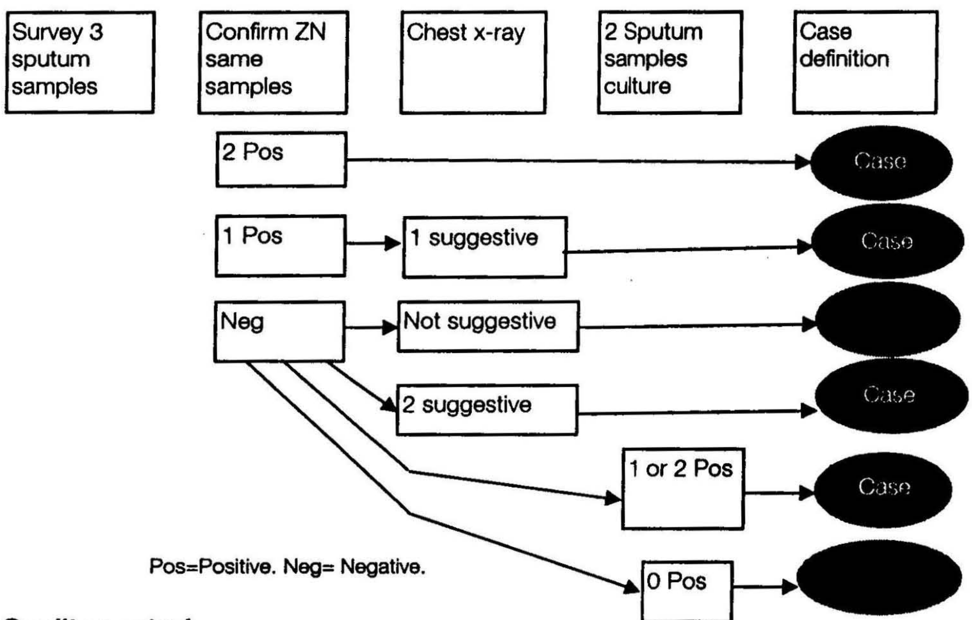
(4) One/two sputum culture-positive (of the 16 suspects and 10 PTB patients confirmed by chest x-ray) was also defined as TB case. Figure 2 shows the case definition procedures.

The rates of smear-negative PTB among the HWs were computed to compare with that of the available national prevalence rate of all forms of TB among the general population aged 15 years and above. This helped understand the magnitude of PTB among HWs engaged in TB control service delivery. Descriptive statistical methods were employed for data analysis and interpretations.

Categorical and numeric data from the additional semi-structured interviews with 10 smear-negative PTB patients and 10 non-TB cases were managed and analysed in SPSS software. T-tests were performed to measure the differences between PTB patients and non-TB cases. Narrative data from the open-ended questions were transcribed verbatim in local language, translated into English and managed manually. The analysis identified perceived cause-related themes/sub-themes, and their features crosscutting and distinctive aspects of causes of TB reported by both

PTB patients and non-TB cases. Quotations were cited from the narrative accounts of the respondents to clarify the phenomena.

Figure 2. Diagnostic algorithm



Pos=Positive. Neg= Negative.

Quality control

All interviewers underwent extensive training on data collection processes and tools. The radiologists of the appointed diagnostic clinic, and the independent CXR examiners were given brief orientations on the essential aspects of the study and why their role would be important was precisely discussed. Five percent of completed interviews of the field interviewers were monitored by separate persons to assess the accuracy and completeness of the data and sputum samples collected, and if any error detected was amended through household revisits. Five percent of the sputum samples as tested by the designated laboratories were randomly drawn and re-tested in an EQA laboratory in Mymensingh for quality control. Besides the field data collection activities, the principal investigator (PI) also continuously supervised laboratory and CXR examination along with the data management activities.

Ethical considerations

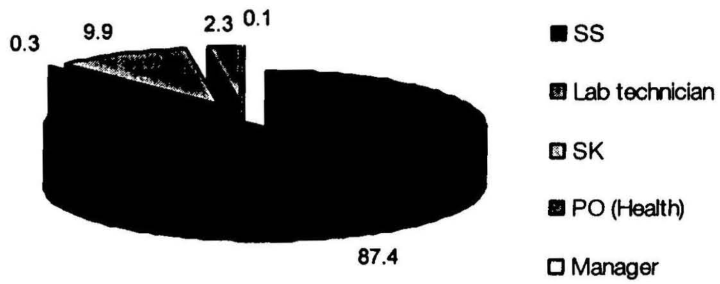
Before launching the study, the Bangladesh Medical Research Council (BMRC) gave the ethical approval. The participants were requested to give their informed consent. They were assured that any refusal would not affect their association with BRAC in any way. The cases found were put immediately on treatment at BRAC programme facilities. Strict confidentiality was maintained in data handling.

RESULTS

Respondents' participation rate

Of the 751 HWs involved in TB control service delivery in Trishal *upazila*, 709 (94.4%) participated in the interviews. SSs represented over 87% of the total participants (Fig. 3).

Figure 3. Percentage of health personnel participated in the study by types



Background characteristics of all the study participants

Of the overall participants, 98.4% were females. The median age of the participants was 39 years (highest 75 and lowest 16 years; table not shown). Nearly half (46.5%) of SSs had no formal education (Table 3).

Table 3. HWs by years of education (%)

Years	HWs by designation				
	SS (n=620)	Lab techni. (n=2)	SK (n=70)	PO (health) (n=16)	Manager (n=1)
0	46.5 (288)	0 (0)	0 (0)	0 (0)	0 (0)
1-5	34 (211)	0 (0)	0 (0)	0 (0)	0 (0)
6-10	19.5 (121)	50 (1)	81.9 (57)	0 (0)	0 (0)
11-12	0 (0)	50 (1)	18.6 (13)	37.5 (6)	0 (0)
13+	0 (0)	0 (0)	0 (0)	62.5 (10)	100 (1)

HW=Community health workers; SS=*Shasthya shebika*; SK=*Shasthya kormi*; PO=Programme organizer. Figures in parentheses indicate number of sample.

Table 4 depicts health workers by different background indicators. Over one-quarter (28.5%) of them was household heads. The median work length of each HW with TB patients was 24 months (highest 300 and lowest 3). Over 98% of them underwent the SS training courses (including TB), followed by 41% maternal and child health. The per capita average dwelling space of most HWs (27.5%) ranged between 50-72 square feet. Measured by self-rated annual economic condition of household, about a quarter of households were reported to suffer from deficits in income compared to the needs. Estimated monthly income of most households (32.7%) ranged between 5,001 and 10,000 Taka (1 USD=69 Taka). Most HWs (87%) reported to have access to safe latrines.

Table 4. HWs by different background indicators

Indicators	Percent/Frequency
HWs by status of membership in the households (n=709)	
Household head	28.5
General member	71.5
HWs by length of work with TB patients (in months)	
Less than 24	41.7
24-60	38.2
61+	20
Median	24
Highest:	300
Lowest:	3
HWs by types of training received (multiple responses) (n=709)	
SS course	98.4
MCH course	40.8
TBA course	2
Other course	2.4
HWs by average size of dwelling space in sq. feet (n=709)	
6-49	24.1
50-72	27.5
73-108	23.8
109+	24.6
HWs by self-rated household economic condition in last year	
Surplus	35.3
Breakeven	39.1
Deficit	25.6
HWs by estimated monthly household income in Taka	
500-3,000	22.7
3,001-5,000	31.3
5,001-10,000	32.7
Place of defecation	
Safe latrines (sanitary/ring slab)	86.6
Unsafe latrines (pit with or without lids/open places)	13.4

Different substance use

A considerable proportion of HWs reported regular usage of various substances that can increase risk of TB. Over 21% were habituated to use of tobacco with betel nuts, 32% burnt tobacco as dentifrice (*gul*), and 44% used scented tobacco (*jorda*) with betel nuts. A few had history of previous abuse of substances (Table 5).

Table 5. HWs by status of substance use (%) (n=709)

Substance names	Status			
	Current (n=709)		Previous (n=709)	
	Yes	No	Yes	No
Smoking	0.6	99.4	0.3	99.7
Tobacco with betel leaves	21	79	1.3	98.7
Burnt tobacco used as dentifrice (Gull)	31.5	68.5	3	97
Scented tobacco with betel leaves	43.6	56.4	2.4	97.6
Smoke ganja	0.4	99.6	0	100

The current users of substances, had been using these for mean duration of 9.8 years, and on average they did it for 4 times a day. The previous users practised different substances for mean duration of 7 years, and they did it for 3.6 times a day (Table 6).

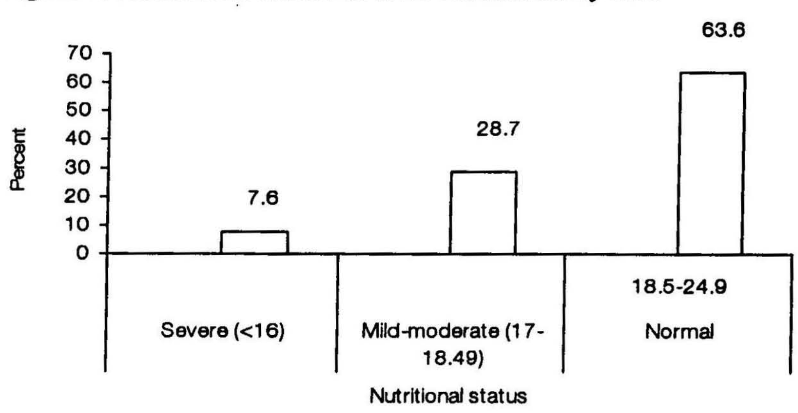
Table 6. HWs using substances by mean years, and daily frequency/number of use (%)

Substance names	Current (n=688)			Before (n=49)		
	Mean years	SD	Daily Freq/ number	Mean years	SD	Daily Freq/ number
Smoking	11.8	1.7	9.3	9	4.2	7.5
Tobacco with betel nuts	12.4	9.9	4.5	9.4	14.5	3.8
Burnt tobacco used as dentifrice (Gull)	7.9	7.5	3.3	6.6	7.8	3.3
Scented tobacco with betel nuts	10	9.4	4.3	5.9	8.1	3.3
Smoke ganja	3.7	1.5	4	0	0	0
Total	9.8	9.0	4	7	9.2	3.6

Nutritional status of HWs

Measured by body mass index (BMI), about 8% of the HWs were severely and 29% were mild to moderately underweight (Fig. 4).

Figure 4. Nutritional status of HWs measured by BMI



Family history of TB

Table 7 shows HWs by history of TB in the households. Eight HWs (1.1%) reported to have TB patients currently in their households. Of the 8 TB patients 6 were male. Half of the patients were aged between 21-30 years and the other half belonged to ≥31 years. Only 25% of these patients received treatment from the public *upazila* health complex (UHC) and the remaining from the BRAC health facilities. Twenty-five percent of them were cured, 25% were continuing the treatment and 50% were not cured. Over 20% of the HWs had TB patients in their households in the past. However, about two-thirds of the cases (65%) were cured by treatment. Less than half of the HWs (43%) received anti-TB vaccination (BCG or Bacille Calmette and Guerin), and of them 90% had scars on the arm.

Table 7. HWs by family history of TB

Indicators	Percent/Frequency
Have currently PTB patients at household (n=709)	
Yes	1.1
No	98.9
Sex of current PTB patients at household (n=8)	
Male	75
Female	25
Age of current PTB patients at household (years)	
21-30	50
31+	50
Current PTB patients by source of treatment	
Upazila Health Complex	25
BRAC	75
Current PTB patients by status of cure	
Yes	25
Continuing	25
No	50
Have past history of PTB incidents at household (n=709)	
Yes	20.9
No	79.1
Sex of past PTB patients at household (n=148)	
Male	80.4
Female	19.6
Past PTB patients by age (years)	
<50	45.3
>=50	54.7
Past PTB patients at household by status of cure with treatment	
Yes	64.9
No	35.1
HWs by status of BCG vaccination (n=709)	
Yes	43.4
No	56.6
HWs receiving BCG vaccination by scar at arms (n=308)	
Yes	90.3
No	9.7

Safety measures taken during interactions with PTB cases

Table 8 shows that more than half of the HWs (53%) did not need to interact with PTB patients as they did not have any such patient under their supervision. Over 38% of the HWs interacted with 1-2 PTB patients daily, followed by 8% with 3 or more. About 45% of the HWs had more than 1-2 interactions daily. Only 44% of the HWs reported to have worn masks during interactions with PTB patients. Most HWs (49%) did not have masks.

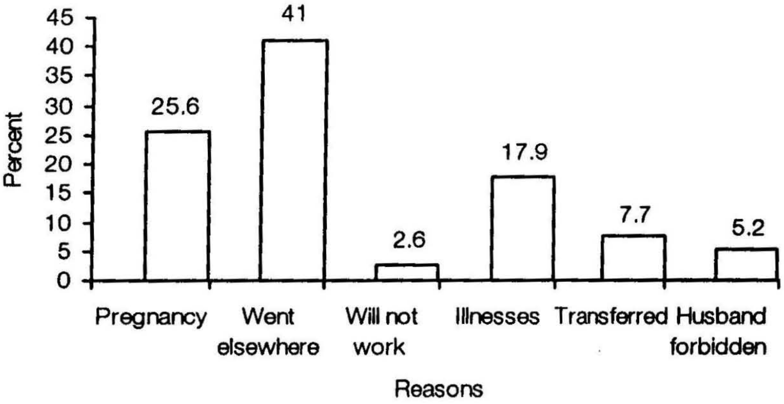
Table 8. HWs by status of interactions with PTB patients and wearing a mask during interactions

Indicators	Percent/Frequency
HWs by average number of TB patients to interact on each day (n=709)	
None	52.9
1-2 patients	38.8
3+ patients	8.3
Average (on all)	0.9
Highest	24
Lowest	0
HWs by frequency of daily interactions with TB patients	
None	52.9
1-2 times	45.1
3+ times	2
Average (on all)	0.6
Highest	8
Lowest	0
HWs by status of wearing a mask during interactions with PTB patients (n=709)	
Yes	44.3
No	55.7
Reasons for not wearing a mask (n=395)	
Have no mask	48.9
Maintain distance from the PTB patients	12.2
No need to wear a mask	7.6
Forgot to wear	1.3
Don't know	3

Reasons for not giving CXR

Of the total 709 HWs interviewed, 39 did not appear for CXR. The majority (41%) reported that they had other commitments on the scheduled day and 26% were excluded due to pregnancy (Fig. 5).

Figure 5. HWs by reasons for not giving CXR



Sputum test results

All sputum sample test results were negative. Five percent of the samples tested at field laboratories were randomly drawn and re-tested for quality control at the NTP External Quality Assurance (EQA) laboratory in Mymensingh. The concordance was cent percent. Additional sputum samples, two (morning and spot) from each of the 26 (10 PTB patients and 16 PTB suspects as confirmed by CXR) were cultured at the NTP Reference Laboratory in Dhaka using the conventional TB culture on Lowenstein-Jensen medium. However, all samples were tested culture-negative.

Prevalence of smear-negative PTB among the HWs

Ten of the total 673 CXR provider-participants were confirmed as patients of smear-negative PTB. All were SSs. Thus, the estimated prevalence rate of smear-negative PTB was 1,612.9 per 100,000 SSs at Trishal *upazila* (10/620*100,000) (Table 9).

Table 9. Parameters for computing the prevalence of smear-negative PTB

Parameters	Number/rate
A. Number of SS participated in the study	620
B. Number diagnosed with smear-negative PTB	10
C. Smear-negative PTB prevalence/100,000	1,612.9*

*The BRAC TB control service statistics of Trishal *upazila* for the period from August 2009 to July 2010 shows an estimated prevalence of PTB 229 per 100,000 among the general population aged 15 years and above.

Operational feasibility of taking CXR

The x-ray machine at the government *upazila* health complex was found to be non-functioning, but adequate facilities were identified in several private clinics. The POs were oriented on the needs for and process of CXR and given responsibility to bring all SSs under their supervision for CXRs on scheduled dates. The research project bore transportation costs and provided food. CXR were obtained from 95% of the HWs in Trishal *upazila*.

A comparative scenario of 10 smear-negative PTB patients (HWs with PTB) and 10 non-TB cases (HWs without PTB) in some important indicators

Types of food consumption

Table 10 shows the average frequency of different types of food consumption in last 12 months by the smear-negative PTB patients and non-TB cases. During the recall period, non-leafy vegetables registered the highest frequency of intake among the smear-negative PTB patients (102) compared with the non-TB cases (86) ($p<0.01$), followed by carbohydrate (99.6 vs. 99.2), fat (79.3 vs. 75.9), animal proteins (71.5 vs. 60; $p<0.01$) and the least intake was fruits (9.5 vs. 19.4; $p<0.01$), followed by plant protein (19 vs. 26; $p<0.01$). The 3 days recall data also indicated that these types of foods were eaten by both the PTB patients and non-TB cases with a slightly varied frequency (Table 11). The overall scenario reveals somewhat an imbalanced dietary habit among the study samples.

Table 10. Average frequency of different types of food consumption in last 12 months by smear-negative PTB patients and non-TB cases

Food types	PTB patients	Non-TB cases	Difference	p value
Animal protein	71.5	60	11.5	<0.01
Plant protein	18.5	26.1	-7.6	<0.01
Carbohydrate	99.6	99.2	0.4	>0.05
Leafy vegetables	29.1	34.4	-5.3	<0.05
Non-leafy vegetables	102	85.6	16.4	<0.01
Fat	79.3	75.9	3.4	>0.05
Fruits	9.5	19.4	9.9	<0.01

Table 11. Average frequency of different types of food consumption in last 3 days by smear-negative PTB patients and non-TB cases

Food types	PTB patients	Non-TB cases	Difference	p value
Animal protein	3.5	2.3	1.2	<0.01
Plant protein	0.4	0.8	-0.4	>0.05
Carbohydrate	3.1	3.1	0	>0.05
Leafy vegetables	0.6	0.5	0.1	>0.05
Non-leafy vegetables	3.1	2.4	0.7	>0.05
Fat	2.7	2.6	0.1	>0.05
Fruits	0.4	0.1	0.3	>0.05

Food insecurity

Incidence of failure in eating three full meals a day in last 12 months (for 1 or more days per month) was higher for non-TB cases than PTB patients (70 vs. 50%) (Table

12). More PTB patients than non-TB cases did not eat meat in last 12 months (80 vs. 60%) (Table 13). The proportion of who could never consume seeds/pulses in last 12 months was identical for both PTB patients and non-TB cases (30 vs. 30%) (Table 14). Table 15 depicted that more non-TB cases than PTB patients could not afford milk for most times (40 vs. 30%). Likewise, more non-TB cases compared with PTB patients failed to eat seasonal fruits (50 vs. 30%) (Table 16). Again, more non-TB cases compared to PTB patients failed to eat eggs in most times (20 vs. 10%) (Table 17). The mean days of deprivation in the consumption of different foods items during the 3-months' recall period were more or less similar for both the PTB patients and non-TB cases (ranging from 2-28 days for PTB patients and 3-28 days for non-TB cases) (Table 18).

Table 12. How frequently did you/your family members fail to eat full meals thrice a day in last 12 months? (%)

Indicators	PTB patients	Non-TB cases	Difference	p value
Never	50 (5)	30 (3)	20	>0.05
Some times (<=1 day a month)	20(2)	30 (3)	-10	>0.05
Most times (>= 4 days a month)	30 (3)	40 (4)	-10	>0.05

Figures in parentheses indicate number of respondents.

Table 13. How frequently did you/your family cook meat in last 12 months? (%)

Indicators	PTB patients	Non-TB cases	Difference	p value
Never	80 (8)	60 (6)	20	>0.05
Some times (<15 days a month)	20 (2)	40 (4)	-20	>0.05

Figures in parentheses indicate cell frequency.

Table 14. How frequently did you/your family cook seed/pulses in last 12 months? (%)

Indicators	PTB patients	Non-TB cases	Difference	p value
Never	30 (3)	30 (3)	0	>0.05
Some times (<4 days a month)	20 (2)	0 (0)	20	>0.05
Most times (every day each month)	50 (5)	70 (7)	-20	>0.05

Figures in parentheses indicate cell frequency.

Table 15. Had you/your family members drank milk in last 12 months? (%)

Indicators	PTB patients	Non-TB cases	Difference	p value
Never	30 (3)	40 (4)	-10	>0.05
Some times (<4 days a month)	40 (4)	40 (4)	0	-
Most times (everyday each month)	30 (3)	20 (2)	10	>0.05

Figures in parentheses indicate cell frequency.

Table 16. Had you/your family members regularly eaten seasonal fruits in last 12 months? (%)

Indicators	PTB patients	Non-TB cases	Difference	p value
Never	30 (3)	50 (5)	-20	>0.05
Some times (<=1 day a month)	60 (6)	20 (2)	40	>0.05
Most times (>= 4 days a month)	10 (1)	30 (3)	-20	>0.05

Figures in parentheses indicate cell frequency.

Table 17. Had you/your family members regularly eaten eggs in last 12 months? (%)

Indicators	PTB patients	Non-TB cases	Difference	p value
Never	10 (1)	20 (2)	-10	>0.05
Some times (<=1 day a month)	30 (3)	40 (4)	-10	>0.05
Most times (>= 4 days a month)	60 (6)	40 (4)	20	>0.05

Figures in parentheses indicate cell frequency.

Table 18. Mean days of events occurred in the last 3 months in households by status of smear-negative PTB patients or non-TB cases

Events	Mean days							
	PTB patients				Non-TB cases			
	Mean	Min	Max	SD	Mean	Min	Max	SD
How many days failed to eat at least a meal due to food shortage/unaffordability?	2.1	0	8	2.8	2.9	0	22	4.5
How many days failed to eat fish?	10.2	2	28	6.4	12.7	2	30	7.6
How many days failed to eat meat?	28.4	24	30	1.8	27.6	2	30	2.0
How many days failed to eat pulse?	22.2	7	30	7.9	17.1	3	30	9.1
How many days failed to drink milk?	18	1	30	10	26.6	12	30	4.9
How many days failed to eat vegetables?	6.6	0	18	4.9	9.3	4	30	6.3
How many days failed to eat eggs?	23.2	10	30	5.4	25.7	19	30	3.5
How many days failed to eat fruits?	21.8	0	30	11.1	25.9	5	30	5.8

Similarities and dissimilarities in certain characteristics of 10 smear-negative PTB patients (HWs with PTB) and 10 non-TB cases (HWs without PTB)

Table 19 shows the smear-negative PTB patients and non-TB cases by different characteristics. A higher percentage of PTB patients than the non-TB cases were underweight measured by BMI (70 vs. 40%). The median length of work of PTB patients as TB service providers was higher than the non-TB cases (36 vs. 19 months). One-fifth of the PTB patients and less than one-third (30%) of non-TB cases were deficit in annual income compared to the needs. More non-TB cases than the PTB patients reported to defecate in safe latrines (90 vs. 70%). The average size of per capita dwelling space was bigger for the non-TB cases compared to the PTB patients (95 vs.78 sft).

PTB patients and non-TB cases did not vary significantly in their likelihood of interacting with PTB patients 1-2 times daily or having a family history of TB. But a larger proportion of BCG vaccine recipient non-TB cases than the PTB patients had BCG scar on their arms (100 vs. 80%). The proportion reported of wearing mask was higher for the PTB patients than the non-TB cases (80 vs. 30%; $p<0.05$).

Table 19. Smear-negative PTB patients and non-TB cases by different characteristics

Characteristics	TB patients	Non-TB cases	p value
BMI, %			
<18.5	70 (7)	40 (4)	>0.05
>=18.5	30 (3)	60 (6)	>0.05
Length of work as TB service provider			
Median months	36	18.7	>0.05
Min.	12	12	
Max.	240	48	
Self-rated economic condition of household, %			
Break-even or surplus	80 (8)	70 (7)	>0.05
Deficit	20 (2)	30 (3)	>0.05
Place of defecation, %			
In safe latrines*	70 (7)	90(9)	>0.05
Per capita mean dwelling space (sft)	77.9	94.7	>0.05
Min.	15.8	23.6	
Max.	138	230	
SD	32.9	64.4	
Daily frequency of interactions with PTP cases, %			
None	60 (6)	60 (6)	>0.05
1-2	40 (4)	40 (4)	>0.05
Have history of PTB incidence in family, %			
Yes	20 (2)	20 (2)	>0.05
Have scar among the 5 BCG recipients, %			
Yes	80 (4)	100 (5)	>0.05
Wear mask during interactions with PTB cases, %			
Yes	80 (8)	30 (3)	<0.05

* Includes ring slab, sanitary, pit with lid. Figures in parentheses indicate cell frequency.

Perceived causes of TB

The smear-negative PTB patients and 10 randomly drawn non-TB cases were asked about the perceived causes of TB occurrence. Table 20 summarises perceived causes reported by both PTB patients and non-TB cases. The patients reported these to explain how they themselves acquired TB, while the non-TB cases reported to explain how one would often acquire the disease. However, both PTB and non-TB respondents frequently reported contact, poverty, hazardous living conditions, heredity, cleanlilessness, hazardous working place, smoking, mental depression, and cold/untimely bathing as perceived causes of TB (Table 20). PTB patients more frequently than non-TB cases reported contact with the programme PTB patients as a cause of their TB. Many respondents from both groups believed that their risk was increased from their responsibility to care/nurse and feed medicines to PTB patients daily. A PTB patient (SS) said:

> *I nursed about 16 PTB patients and fed them medicine [or medications]. They used my glass while taking medicine [or medications], and I drank water with that glass. They talked to me open mouthed without any cover. They often coughed up and spit sputum here and there. Thus, TB germs infected me. Despite my earnest request, the programme's PTB patients never covered their mouths during interactions.*

Patients also referred to a lack or shortage of foods vis-à-vis intake of poor nutritious food as a cause of TB. *"Insufficient food intake dries up one's stomach, resulting in weak immune systems. And the disease occurs in a weak body,"* commented a PTB patient.

Both PTB and non-TB respondents expressed damp and crowded dwelling houses, dirty and water-logged living conditions could cause TB. A PTB patient said, *"Germs grow in dirty and water-logged places, resulting in air pollution around. Thus, germs enter into body through inhalations."* Some respondents further said that stepping over dirty water might have caused TB, while some blamed lack of sunlight and ventilations at their living places.

Most respondents, especially the non-TB cases specified TB as a family event (heredity). A mother with TB would infect her child. Living with or caring for a family member with TB could also transmit the disease to other family members. Though no respondents smoked, many reported that smoking could cause TB. More PTB patients than the non-TB cases mentioned that mental health issues, such as worries, tensions arising from poverty, spoiled conjugal life, and death of husband might have caused TB among them. A PTB patient cited, *"Body loses energy for bad thinking and anxieties, resulting in weakness and disease occurrence."*

Hazardous working places such as TB room of BRAC TB control programme, factories (iron, garments, and vehicles) were perceived as causes of TB. *"Work with TB patients at BRAC TB control programme room has caused my TB,"* said a PTB patient. Some PTB patients identified hard work or physical exertion as cause of TB. *"I do a hard work every day for selling medicines in the villages and for my family. This may have caused my TB,"* said a PTB patient. Most TB patients reported that prior illnesses, i.e., suffering from other diseases before TB incident, caused their TB. *"I suffered from kaalajar for a long time which weakened my health and it was a big cause of my TB,"* commented by a PTB patient. Some respondents, especially the TB patients blamed supernatural causes for their disease. Other believed that stepping over contaminated water or sputum of TB patients could cause TB. *"Stepping over a TB patient's sputum causes TB,"* said a PTB patient.

Table 20. Perceived causes of tuberculosis among TB patients and non-TB cases

TB patients	Non-TB cases	Both
Contact	*Contact*	*Contact*
....	- Patients are unaware about wearing mask, and move unconsciously in public places such as buses, tea stalls or in a meeting place, and spread germs through sneezing, coughing, and tea cup. - Flies often carry germs from the patients' sputa and then sit on food, and thus contaminate the food that human eat. - Taking food together or sharing of food or bed or materials.	- Caring/nursing of TB patients. - Mixing with patients. - Inhaling patients' breath during direct interaction (patients spread germs through sneezing and coughing). - Inhaling dust with germs from the air.
Poverty	*Poverty*	*Poverty*
....	- Lack of nutritious food/vitamin (vegetables, fish, and meat).	- Lack of food/insufficient food intake.
Hazardous living conditions	*Hazardous living conditions*	*Hazardous living conditions*
- Germs grow in dirty and water logged places, polluting the air in the surrounding area. Thus, the germs enter into body through inhalations. - Enter germs into body while stepping over dirty water.	- Unhygienic conditions around the home/ presence of bushes around the home (germs grow in such environment and spread). - Lack of sun light and wind flow.	- Damp and congested dwelling-house.
Heredity	*Heredity*	*Heredity*
....	....	- Heredity (mothers to baby/ infected family member to others).
Smoking	*Smoking*	*Smoking*
....	- Smoking (firstly breathing problem, then TB).	- Smoking.
Cleanlilessness	*Cleanlilessness*	*Cleanlilessness*
....	- Eating food without washing hands and face. - Habit of toilet use without slipper.	- Unclean condition around the home.
Mental depression	*Mental depression*	*Mental depression*
....	- Tension may also cause TB.	Worries stemming from poverty, separation from conjugal life, death of husband, and any kind of shock.
Hazardous working place	*Hazardous working place*	*Hazardous working place*

(Table 20 continued.............)

(.............Continued table 20)

- Work at BRAC TB programme room or hospital with TB patients. - Work in iron factory.	- From dust of garments factory (TB infection in garments worker is higher). - Steam of vehicle factory (germ enter into body with polluted steam water).	....
Hard work	*Hard work*	*Hard work*
Hard working /hard labour (Physical exertion).	....	....
Prior illnesses	*Prior illnesses*	*Prior illnesses*
- Prime diseases *kaalajar, cough followed by* TB. - TB reappeared after 4/5 years of TB incidence.	- Somebody gets TB from tumour, fever, and mouth infection.	....
God gifted/Supernatural	*God gifted/Supernatural*	*God gifted/Supernatural*
- Misfortune/fate. - Polluted air (sometime thinking it takes place from bad air).	- Bad air (*Baula Batash*).	....
Cold/untimely bathing	*Cold/untimely bathing*	*Cold/untimely bathing*
....	....	- Cold stemming from irregular/untimely bathing/rain (at night).
Others	*Others*	*Others*
- Stepping over a TB patient's sputum causes TB.	....	....

DISCUSSION

Among the different types of health providers involved in TB service delivery at community level of Trishal *upazila*, the smear-negative PTB was found to be prevalent among the *shasthya shebikas* at the rate of 1,612.9/100,000. This rate is 4-fold higher than the prevalence of all forms of TB (WHO 2011) in general population of Bangladesh. Studies conducted in different countries between 1997 and 2006 report 1.6-13.8 fold higher incidence of TB among the healthcare workers than the general populations (Alonso-Echanove *et al.* 2001, Harries *et al.* 1999, Kanyerere and Salaniponi 2003, Rao *et al.* 2004, Naidoo *et al.* 2002) (Table 21). However, a study in South African hospital (Wilkinson *et al.* 1998) reports that the TB incidence rate among healthcare workers is 558/100,000 person year, which is lower than the incidence rate among the general population of the country (1,543/100,00 person year). This might have been due to the higher prevalence of HIV infection causing TB co-infection leading to higher prevalence of TB among the general population.

Table 21. Incidence of TB disease (all forms) in healthcare workers in low and middle-income countries

Author, year, reference	Country	TB incidence among HCWs/100,000/yr	TB disease incidence in the country/100,000/yr	Differences in rates (+/-)
Harries, 1999	Malawi	3,550	389 (1996)	9.1
Kanyerere, 2003	Malawi	5,780	419 (2001)	13.8
Rao, 2004	India	1,260	168 (2002)	7.5
Alonso-Echanove, 2001	Peru	391	111 (1998)	3.5
Naidoo, 2006	South Africa	1,180	718 (2004)	1.6

Source: Extracted from Menzies *et al.* 2007.

The x-ray machine at the government UHC was found to be non-functional. This appears to be a common feature at public UHCs. In Trishal, more than one private clinics equipped with x-ray facility were available. This is probably due to its proximity to Mymensingh district town where two medical colleges (one public and one private) are located. Prior launching such study in other settings, availability of functional x-ray facility within the accessible distance should be explored first. Examination of how female providers of CXR, engagement of supervisors, and use of incentives/reimbursement may also yield different rates of CXR utilization.

Perceived causes may influence healthcare-seeking behaviour for TB (Auer *et al.* 2000, Liefooghe *et al.* 1997). An open-ended question to both TB patients and non-TB cases about the causes of TB produced a wide array of responses with a minor difference between the groups. The important among others were 'contact' (with TB patients), 'poverty', hazardous living conditions, heredity, smoking, cleanlilessness, 'mental depression', ' hazardous working place', 'hard work', 'prior illness', 'result of divine action', and 'cold'.

However, most frequently cited cause was 'contact' with TB patients. Similar findings were reported by many studies (Liefooghe *et al.* 1997, Auer *et al.* 2000, Promtussananon *et al.* 2005, Weiss *et al.* 2008, Karim *et al.* 2010). Most respondents as a part of their routine job have had contact and interactions with known TB patients. They are to search for TB suspects, treat and follow-up the patients diagnosed with TB. They also share their glasses with the patients during DOT execution at homes. Such sharing could be a major source of infection (Liefooghe *et al.* 1997). HWs, therefore, should ask the PTB patients attending DOT session to bring their own glasses for drinking water while swallowing medicines. Dirty (Auer *et al.* 2000), damp, crowded and dusty living environments are also perceived as causes of TB. Many participants live in such conditions and consequently are at a higher risk of TB infection.

Personal protective measures such as wearing a mask during interactions with TB patients may help prevent disease transmission. Though most TB patients compared with non-TB cases in this study claimed to have had put mask while interacting with patients at community, this was likely over reported. Efforts must be made at the global level to increase financial support for infection control and develop methods that are feasible in resource-limited settings.

TB is considered to be a disease of poverty (WHO 2002) and malnutrition. Poverty-stricken people often fail to eat adequate vitamin-rich foods, resulting in weak immunity. Thus, their body often fail to defend the invasion of TB infections. Most TB patients (70%) in this study were undernourished measured by BMI, compared with non-TB cases (40%). Malnutrition generally results from a lack of either protein, which is essential for muscle development and maintenance, or micronutrients such as iodine, vitamin A, or iron, which boost immunity and healthy development. But data generated about types of food consumptions using varied recall periods did not produce enough evidence of vitamin-rich food intake by either group of respondents (TB patients and non-TB cases), though routine consumption of sufficient vitamin-rich foods increases immune functions toward disease prevention.

Limitations of the study

1. All smears were tested negative at direct microscopic laboratories in the field. Whereas 10 cases were detected by CXR as PTB-positive. In fact, reader's ability to detect abnormal opacities and interpret them correctly largely determines the usefulness of chest radiography. Koppaka *et al.* (2004) cite that a Danish group consisting of three expert readers has examined 5,000 unselected small films independently. On average, under-reading has occurred in 32% of cases and over-reading in 2%. This implies that diagnosis based on CXR has a higher propensity toward under diagnosis of PTB. This may also be true for our study. Thus, reader's variability often undermines the efficacy of CXR in PTB diagnosis. In our case, we used two expert radiologists and one chest

physicians for reading the CXRs. At least two of them confirmed PTB-positivity in 10 cases by CXR, one of the experts suspected PTB in 16 and the remaining were reported to be normal. For further checking, we collected additional sputum samples (2 from each of the 26 including the 10 PTB-positive patients as determined by CXR reading) and cultured at the NTP Reference Laboratory in Dhaka. Similar to all negative results of direct smear test for AFB at field laboratories, all culture results were found to be negative. Evidently, sputum culture often do not produce effective positive results if the facility suffers from operational disadvantage such as specially trained and skilled personnel (Harries 2004) or contamination of reagents used. Given this, based on the CXR results confirmed by at least two experts, we labelled 10 cases as smear-negative PTB, and thus computed the prevalence of smear-negative PTB among the study HWs. However, other expert may label these cases as suggestive of smear-negative PTB patients.

2. The study represents the scenario of an *upazila* only, and the results, therefore, better not be generalised for all *upazilas* under BRAC TB control programme.

CONCLUSION

This pilot study provides supportive evidence that frontline providers of community-based TB care, especially *shasthya shebikas,* have an increased risk of acquisition of occupational TB. As at current there are the limited resources for and implementation of infection control measures in these settings, this research indicates that more attention must be given to protecting the health of providers of TB care. We find that CXR are feasible in this setting. HWs with low nutritional status are at higher risk of PTB.

RECOMMENDATIONS

Minimizing the occupational risk of acquiring TB is critical in LIMC where human resources for health are already scarce. Based on our findings that a significant risk exists for BRAC's community-based TB control activities, particularly among the volunteer cadres, we recommend the following strategies to reduce the risks:

1. An expanded study may be instituted drawing samples from a wider number of *upazilas* under the purview of BRAC TB control programme to evaluate the prevalence of PTB among the BRAC HWs.
2. Routine annual check-ups for HWs may be developed and implemented. For this, accomplishment of the following actions may be beneficial:
   (i) During routine refresher course, case history may be tracked for each HW, and sputum of all symptomatic should be tested at nearby laboratory within the programme frame. Chest x-ray can be applied for the persons whose symptoms persist despite sputum test-negative.
   (ii) In case of failure of sputum test and CXR as diagnostics, sputum may be cultured at the NTP reference laboratory in Dhaka.
   (iii) Diagnosed patients should be supported in prompt initiation of treatment and receive appropriate follow-up.
3. Personal and administrative measures for controlling occupational transmission, such as maintaining proper cough hygiene, wearing mask, early suspicion of TB, early treatment initiation, etc. should be rigorously implemented (Table 1).
4. During administration of DOT at a HW's home, a patient should bring his/her drinking water glass for use while swallowing medicines.

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