Assessment of the delay in diagnosis and treatment initiation among TB patients and acceptability of a tuberculosis notification app (Janao) among private providers

Final Project Report

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Abbreviations and Acronyms

BMI	Body mass index
BSMMU	Bangabandhu Sheikh Mujib Medical University
CI	Confidence Interval
COVID-19	Corona Virus Disease 2019
DOTS	Directly Observed Treatment, Short-course
GoB	Government of Bangladesh
HIV	Human Immunodeficiency Virus
IDI	In-Depth Interview
MBBS	Bachelor of Medicine and Bachelor of Surgery
MDR	Multi Drug Resistant
NTP	National Tuberculosis Control Programme
OR	Odds Ratio
PTB	Pulmonary TB
PP	Private Practitioners
RDM	Research for Decision Makers
RR	Rifampicin-Resistant
SD	Standard Deviation
SEM	Social Enterprise Model
SSC	Secondary School Certificate
TB	Tuberculosis
TBSTCs	TB Screening and Treatment Centres
TR	Treatment Registration
UNHLM	United Nations High-Level Meeting
USAID	United States Agency for International Development

Executive Summary

Background

Pulmonary Tuberculosis (TB) transmits from person to person by respiratory route, if untreated. In 2019, there were an estimated 10 million TB cases globally, of which only 7.1 million were reported, leaving a gap of 29% missing cases. In Bangladesh, the estimated incidence in 2019 was 361,000, where 19% of the cases were missing. The gap (missing TB cases) between the estimated number and the actual reported number is either due to underdiagnosis (lack of access to healthcare or timely diagnosis) or underreporting of detected cases.

Delay in diagnosis and/or delay in treatment initiation after onset of symptoms may lead to increased TB transmission, morbidity and mortality. icddr,b TB Screening and Treatment Centres (TBSTCs), under the National TB Control Programme (NTP) offer modern TB diagnostic tests and recommended TB treatment, all free of cost. In this study, we aimed to estimate diagnostic and treatment delay, along with related factors, from TB patients attending the TBSTCs.

Missing TB cases in the country are likely to be stemming from private healthcare providers. The government of Bangladesh declared TB a notifiable disease in 2014 to link private providers for reporting TB cases. icddr,b developed the "Janao" app for NTP as a platform for notification of TB cases, which was piloted among PPs and DOT providers in Dhaka city in 2019. We aimed to assess the new app's acceptability among the users - physicians and DOT providers.

Methodology

This was a mixed methods study. We interviewed participants between December 2019 and March 2021. A quantitative survey was carried out among 895 pulmonary TB (PTB) patients attending the icddr,b TBSTCs based in Dhaka city to investigate the delay in diagnosis and treatment initiation. For the qualitative component of the patient delay part, 21 individuals were selected for in depth interviews (IDIs). To assess acceptability of the Janao app among the registered users of Dhaka, for the quantitative component, we enrolled 223 physicians and 94 DOT providers, who were engaged with the app for case notification and for treatment enrolment recording respectively. For the qualitative part, we conducted a total of 16 IDIs among them. The study team were trained on quantitative and qualitative part of the research protocol, consent forms and questionnaire/guideline. We have analyzed the quantitative study data using the main variables and related variables with support from a statistician. We followed a thematic analysis approach for the qualitative analysis with support from a qualitative research expert.

Findings and discussion for patient delay part

On average, the 895 study participants were of 37±16 (mean±SD) years of age, majority of them were males (69.9%), from the urban areas (82.3%), and were

bacteriologically confirmed cases of TB (97%). Their Body Mass Index (BMI) was 20.1±3.8 (mean±SD) kg/m^2, 87% of the participants had no university degrees, and more than 50% of the participants earned less than 20,000 taka per month, when interviewed.

The cardinal symptoms of TB like cough >2weeks (83.3%), fever (84.0%), significant weight loss (83.7%) and night sweats (60.1%) were present among majority of participants. Among these participants, the median (IQR) patient delay was found to be 47 (43) days, with the delay in TB diagnosis being quite high at 45 (40) days, while delay in treatment initiation was 2 (2) days.

Studies conducted in several other countries have shown the median diagnostic delay to be quite varied, between 23 to 91 days, while treatment delay was shorter at 1-8 days, which showed similar trend to the findings of our study. The median total delay in the different studies was 35 to 97 days from the onset of TB symptoms to the initiation of TB treatment. As we considered the cut-off for symptom onset to treatment initiation as 30 days, in our study population, over two-thirds were found to have a delay in seeking treatment since symptom onset. Different studies from different countries found various factors to be relevant to the diagnostic and treatment delays. Being conducted in a major metropolitan city, where patients are also referred from throughout the country (mostly from private sector providers), our study represents a mixed population seeking healthcare from a public-private mix setup. On regression analysis, after adjusting the covariates, we found the predictors of the delay to be those with cough >2 weeks, night sweats, diabetics, those who initially self-treated, those who required a longer to reach a confirmed diagnosis, and those who were bacteriologically diagnosed, which relate to the factors found in similar studies.

Our qualitative study findings showed that health-seeking behavior played a crucial role in this aspect. It was reported that a significant number of participants tended to seek treatment or prioritized quack doctor or huzur (spiritual healer). Also, the practice to visit formal physicians was reported only in the phase of the worst physical condition. Besides, tendency of visiting formal physicians because of family pressure was noticed in our study. Negligence about sign symptoms, lack of knowledge of TB, and financial insolvency had been mentioned as the reasons for the patient delay. Study findings showed that the symptoms of TB were perceived as seasonal fever and cough which did not bother the patients initially. Simultaneously, financial insolvency by the participants belonging to low socioeconomic profiles was reported as another significant reason for delayed health care seeking.

Findings and discussion for acceptability of Janao part

The 223 doctors were of 45±10 (mean±SD) years of age and 86% were males. They had diagnosed 20 (41) [median (IQR)] TB patients and notified 5 (8)

[median (IQR)] TB patients after they were registered with the app. As they reported, time required to notify TB patients using Janao was 4.4±2.4 (mean±SD) minutes. Most other findings on acceptability of the Janao app were based on Likert scale.

Regarding doctors' engagement with the application, most of them agreed or strongly agreed on the options - Janao application is a good way to notify TB patients (80.3%), the application should be used by every physician diagnosing TB patients (88.3%) and orientation & training to use the application was good enough (57.4%). Regarding difficulties with the application, majority of them agreed or strongly agreed that time required to notify a TB patient was short enough (61%) and they somewhat disagreed, disagreed or strongly disagreed that there were some difficulties using the application (67.2%).

The 94 DOT providers were of 34±9 (mean±SD) years of age and 55% were females. They had received 22 (23) [median (IQR)] TB patient notification and recorded enrolment of 12 (15) [median (IQR)] TB patients through Janao app after they were registered with the app. As they reported, time required to communicate about a TB patient using Janao app was 4.0±4.0 (mean±SD) minutes.

Regarding DOT providers' engagement with the application, most of them agreed or strongly agreed on the options - Janao application is a good way to notify TB patients (91.5%); the application should be used by all DOT providers enrolling TB patients (96.8%); and orientation & training to use the application was good enough (90.4%). Regarding difficulties with the application, majority of them agreed or strongly agreed that time required to communicate a TB patient was short enough (80.8%); and they somewhat disagreed, disagreed or strongly disagreed that there were some difficulties using the application (57.5%).

The app's acceptability by both doctors and DOT providers was positive by our Likert scale findings. The app has the potential to notify a greater number of TB patients. After the primary training/engagement, the number of TB patients diagnosed by the doctors was four times higher than the number of patients they had notified through the app. This may be the result of the doctors' busy schedules and the newness of the app. The number of TB patients' information the DOT providers received through the app was found to be two times higher than the number of patients' enrolment information the DOT providers had entered into the app. This may have been due to lack of available digital devices/internet in the DOTS centres, changes of the duty locations of the DOT providers and the app being a new intervention.

Our qualitative study findings revealed the positive acceptance of the app by healthcare practitioners and DOT providers. The app was perceived by the

physicians to be useful for linking to TB treatment facilities as well was appraised as a tool for TB patient notification and learning treatment enrolment status. However, the physicians and DOT providers recommended that further training/orientation sessions will be helpful to increase engagement of the users. In addition, some of the DOT providers reported that lack of availability of smartphone/internet is a barrier in using Janao app.

Recommendation

Awareness building for TB should continue, including disease symptoms and where to seek care. Connecting informal providers with national TB control program, active case finding and ensuring access to TB care services will also help.

Engagement of the PPs & DOT providers for scaling up Janao should continue, including provision of further training/orientation for all the users, and digital devices and internet for the DOT providers.

Background

Tuberculosis (TB) is a chronic infectious disease caused by *Mycobacterium tuberculosis*, the source of infection being patients with untreated bacteriologically-positive pulmonary TB (PTB) who are discharging the bacilli. The estimated 10 million cases and 1.2 million deaths in 2019 indicate that TB is still a worldwide concern, as only 71% of estimated TB cases are notified (1). The gap between the actual reported number and the estimated number is due to a mixture of underreporting of detected cases and underdiagnosis (because of lack of access to healthcare or timely diagnosis). Two-thirds of the world's estimated TB cases in 2019 were in eight countries, including Bangladesh (population of 163 million), which is included in the World Health Organisation's lists of high-burden countries for both TB and multidrug/rifampicin-resistant TB (MDR/RR-TB). The estimated incidence of TB in Bangladesh is 218 per 100,000 people, and 27 per 100,000 people die from it (1).

The diagnosis and successful treatment of patients with TB avert millions of deaths every year, but a large and persistent gap in detection and treatment remains. One of the several challenges currently present is delay in diagnosis and anti-TB treatment initiation after symptom onset. Patient delay, which includes delay in diagnosis and/or treatment initiation after diagnosis, leads to increased spread of infection in the community, progressive disease severity and a higher risk of mortality. Relevant studies are few, and the lack of data is a major obstacle in setting strategies and policies to mitigate this challenge. This is even more prominent in Bangladesh due to different contextual factors. Under the National TB Control Programme (NTP), icddr,b has been offering modern TB diagnostics through the TB screening and treatment centres (TBSTCs) established as a social enterprise model (SEM) since 2014 along with TB treatment facilities through the Directly Observed Treatment, Short-course (DOTS) strategy from 2017 (2). The centres are located in places that facilitate easy access for the maximum number of patients seeking healthcare in the private sector. The SEM has also developed a referral network of private and public healthcare facilities, including private practitioners (PPs), pharmacies and DOT providers to refer presumptive PTB patients to TBSTCs. After symptom screening, sputum testing by GeneXpert and a chest X-ray, a considerable number of patients are diagnosed and treated there. This has created an opportunity to estimate the actual scenario of diagnostic and treatment delay and investigate related factors by interviewing patients with TB from the TBSTCs. We aimed for this study to generate evidence about the gaps in the patient pathway via estimating the delay in diagnosis and treatment; the results could be utilised by policymakers in developing strategies to bridge those gaps.

Another considerable challenge hampering TB control measure is the huge volume of missing TB cases in the country, likely stemming from private healthcare providers. In Bangladesh, 19% of the total estimated TB cases were missing despite 100%

DOTS coverage, including free TB treatment (1, 3). As a mitigation strategy, the Government of Bangladesh (GoB) declared TB as a notifiable disease in January 2014 to link the patients from private providers to the reported volume of cases. The USAID has been supporting the development of a TB notification system, which has been supplementing the GoB gazette. In 2016, USAID's Challenge TB, Bangladesh (CTB) funded a survey to understand the feasibility and suitability of a notification platform. Consequentially, informed by the survey findings, a digital tool for TB notification, Janao, was developed by icddr,b with support from USAID's CTB in 2018. Digital tools can fill the gap of availability of TB notification facilities and create access to large volume of data on TB patients distribution in big cities (4). The Janao app as a TB notification tool was piloted among PPs and DOT providers within Dhaka by icddr,b under the guidance of the NTP and again funded by USAID's CTB in early 2019. It enabled PPs to notify the NTP of patients with TB, allowing the DOT providers of each patient's preferred location to follow up with the patient as soon as possible. Many prominent private providers have shown great interest in using the tool. From mid-2019, the activities to implement Janao app as a notification tool were carried out by funding from USAID's Research for Decision Makers (RDM) project. Studies in different countries showed that a small percentage of physicians feel the obligation towards communicable disease reporting, which is even worse among physicians from the private sector (5). Thus, the national data of patient notification are not often representative of the actual scenario. Similarly, adherence to TB notification is a challenge in the private sector despite having predominance on delivering health services, especially in big cities (4, 6). Digital tools for TB notification can help in addressing several challenges that are required for effective implementation (5-7). However, as a novel digital tool, Janao app's acceptability remains unclear in our context. To make the initiative sustainable and convenient for all users, this study interviewed several users (physicians and DOT providers) on the app's acceptability considering further scale-up among larger group of users in the country. The findings will inform future updates of the app, rendering it more useful and convenient for users, which will ultimately help to reduce the number of missing TB cases, especially from the private providers.

Objectives

1. To estimate the delay in diagnosis and initiation of treatment after symptom onset
2. To identify the factors associated with the diagnostic and the treatment delay of TB patients
3. To assess the acceptability of the Janao platform as a TB notification tool among private healthcare providers
4. To assess the acceptability of the Janao platform as a TB notification tool among DOT providers

Methodology

Study design:

We conducted a mixed-method study to identify diagnostic and treatment delay and related factors. Qualitative methods were utilised to relate the quantitative findings and document different patient perspectives on the delays.

To assess Janao's acceptability, we conducted the interviews with a quantitative and qualitative questionnaire. Private practitioners who diagnose patients with TB and DOT providers who maintain patient treatment were approached, provided they were oriented in using the app.

Study sites:

Seven icddr,b TBSTCs situated in Dhaka Metropolitan City were included in this study. These centres are well equipped with high-quality digital X-ray machines and Xpert facilities. A good number of presumptive PTB patients are referred from PPs and pharmacies to these centres while some people visit the centres by themselves without a referral. Here the patients are tested with a chest X-ray and an Xpert test for sputum, and a considerable number are diagnosed with TB.

We also included the practicing sites/workplace of the PPs and all of the DOTS facilities of Dhaka to approach the study participants from there. We utilised the most convenient place preferred by the physicians to conduct their interviews on Janao.

Study period:

We conducted all data collection for patient delay and the acceptability of Janao between December 2019 and March 2021.

Study population:

To enrol quantitative study participants, TB cases diagnosed at the icddr,b TBSTCs and those diagnosed elsewhere but visited the centres for treatment were included if they met the study criteria and consented to participate in the study. PPs oriented with Janao and DOT providers in Dhaka were approached to be interviewed on their usage experience with the app. We identified a subset from both the survey respondents purposively to enrol the qualitative study participants. We considered the sociodemographic characteristics of the participants, and insights from the quantitative interviews and findings. For the patient delay part, length of diagnostic and treatment delays, distance from their current location to healthcare facilities and the COVID-19 lockdown situation were also considered. For the Janao acceptability part, variability of institutional affiliation, practice location and availability of the physicians for a longer interview were taken into consideration.

Inclusion criteria:

- PTB patients attending icddr,b TBSTCs in Dhaka
- Doctors and DOT providers registered with the Janao app

Exclusion criteria:

- Extra-PTB patients
- Seriously ill/hospitalised patients
- Participants unwilling to consent

Sample size:

To estimate the patient delay, the calculated sample size was 646 patients with TB. We assumed a mean patient delay of 54 days, ranging from 7 to 120 days for an estimated standard deviation of 28 days; this was estimated within 4% relative precision with a 95% confidence interval (8). Considering a 10% non-response rate, the sample size was set to 710 patients with TB. As Corona Virus Disease 2019 (COVID-19) occurred within the study timeline, enrolment was continued beyond the proposed sample size to capture COVID-19 perspectives, if any, in the data. The additional sample based on the interim findings was determined to be 235. Ultimately, during the study period, 895 PTB cases were enrolled from the study facilities. For the qualitative exploration, we conducted in-depth interviews (IDIs) with 21 participants.

To assess the acceptability of Janao, all physicians and DOT providers registered in the app were approached for quantitative interviews. Ultimately, 223 physicians and 94 DOT providers consented and enrolled. For the qualitative part, we conducted 16 IDIs, 9 with physicians and 7 with DOT providers.

Photo 1 & 2: Training of the study team

Staff training:

Before initiation of field implementation, the study team, comprising field research assistants, health workers and community volunteers of the TBSTCs, were oriented on the study, the required activities and their responsibilities. With the overall supervision of the principal investigator, the project coordinator and senior research investigator provided the study team with detailed training on the study protocol, consent forms and questionnaires. This involved an interactive session of practising consent taking and interviewing the respondents by role play. A field research officer was responsible for supervising the day-to-day field activities under the overall guidance

of a medical officer. For the qualitative part, a research officer was engaged to enrol the study participants and conduct the qualitative interviews under the supervision of a research investigator with qualitative expertise.

Operational definitions:

- **Diagnostic delay:** the time interval from the appearance of major symptoms until the disease diagnosis.
- **Treatment delay:** the time interval from disease diagnosis to treatment initiation.
- **Patient delay:** the delay in TB diagnosis after symptom onset and/or delay in treatment initiation after TB diagnosis.

Data collection:

Regarding patient delay, the quantitative interviews with the participants were conducted using tab-based questionnaires. Information on the socio-demographic, economic and clinical characteristics, knowledge and awareness, healthcare-seeking behaviour, perceived cause of delay, access to healthcare and transport cost of the consenting participants was collected to assess the relevant factors leading to delay in the diagnosis and the treatment initiation of patients with TB and other pertinent findings. We also conducted IDIs to understand the insiders' perspectives on the overall problem and challenges during diagnosis and initiation of treatment as well as to document the understanding of the delays between onset of TB symptoms and treatment initiation.

Regarding the acceptability of Janao, we interviewed both PPs and DOT providers to understand their experience using the application. This quantitative part included the acceptability of the notification tool in terms of engagement, ease of use and usefulness as well as difficulties in using the application, mostly using a Likert scale. In addition, we conducted IDIs to gain more detailed insight into the users' experiences with the tool and their perspectives. All qualitative interviews were audio recorded upon formal approval via informed written consent and then transcribed verbatim. Additionally, notes were taken and summarised to be utilised for triangulation.

Enrolment of study participants:

Patients diagnosed with TB in icddr,b TBSTCs were approached and enrolled for the quantitative interviews. We purposively selected IDI participants considering their age group, sex, education, socioeconomic status and occupation. Meanwhile, all registered physicians and DOT providers registered in Janao were approached for the quantitative interviews. Based on usage of the app, we purposively enrolled those who consented and participated in the quantitative part for the IDIs.

Photos 3 & 4: Consent taking & interview

Data analysis:

We analysed the data using statistical software Stata/SE 15 (StataCorp LP, USA) and relevant statistical methods. The primary outcome variable was patient delay including the delay in diagnosis and/or treatment initiation after diagnosis. The other related variables were socio-demographics - such as, age of participants, gender, educational status, marital status, living area and body mass index (BMI); clinical variables – such as, type of TB case, history of TB contact, cough and its duration, haemoptysis, fever, night sweats, significant weight loss, fatigue, loss of appetite, shortness of breathing, wheezing, diabetes and hypertension; and knowledge and healthcare seeking behaviour related to TB. The acceptability of Janao was measured mainly using Likert scale. We also included variables like age, gender, number of TB patients diagnosed or number of notification received, number of TB patients notified or enrolled and minutes taken to notify/communicate a TB patient. We used descriptive statistics, e.g. frequency, proportions, mean and median, to report the socio-demographic details, nutritional status, symptom profile and TB notification/diagnosis data. We calculated the wealth index, i.e. a composite measure of a household's cumulative living standard, as a background characteristic of the patients using the principal component analysis method (9-11). We scored households based on different assets that yielded five quintiles – poorer, poor, middle, rich and richest. To identify the predictors of delay, unadjusted logistic regression was conducted to measure the association of patient delay with the patients' socio-demographics and TB knowledge and awareness. Multivariate logistic regression was then performed to adjust the statistically significant covariates to determine the factors related to patient delay. The odds ratio (OR) with a 95% confidence interval (CI) was measured considering two-tailed tests of significance. To understand the effect of the COVID-19 lockdown, the Mann–Whitney U test was performed to compare the median time durations, and a chi-square test was performed to compare the associations. We followed the thematic analysis approach in the qualitative data analysis. The qualitative team transcribed the audio recordings of interviews, analysed the data and created coded documents. The

documents were subsequently re-read, conceptualised and categorised by the emerging themes to prepare the report.

Results

Findings for patient delay

Key Quantitative Findings for Patient delay

- ***Knowledge and awareness of TB:*** Majority (95%) had heard about TB before, and were familiar with its symptoms before being diagnosed (86.2%). Of them two-thirds (63.7%) had a moderate level of knowledge regarding TB, having heard of it through family and friends (61.1%) and advertisements (60.9%).
- ***Healthcare-seeking behavior:*** Two-fifth of participants had their first visits at either their nearby pharmacies (42.1%) or private health facilities (40.9%). The median time between first care-seeking visit and confirmed TB diagnosis was 28 days. Two-thirds of participants (71.7%) had a perceived delay in diagnosis – mostly as they hoped symptoms would resolve on their own (82.5%).
- ***Access to health facilities:*** The mean distance of the nearest health facility and the nearest DOTS centre from their home was 2.4 km and 2.5 km respectively. Majority (91%) reported that the mean time it took to travel there was 21.4 minutes. Median transport cost to commute to and from the nearest DOTS centre to their residence was an average of 1,200 Tk/month.
- ***Delay in diagnosis and treatment initiation:*** Median delay, from symptom onset to confirmed diagnosis, was 45 days, while the median delay between diagnosis and treatment initiation was minimal (2 days). Thus, reported median total delay was 47 days. The predictors for patient delay, after adjusting covariates, were cough >2 weeks (OR 2.44), night sweats (OR 0.55), diabetes (OR 1.95), time between first visit and confirmed diagnosis (OR 1.09), type of TB patient (OR 3.7), self-treatment (2.05).
- ***Effect of COVID-19:*** Majority participants (71.7%) enrolled before the sudden countrywide lockdown due to the COVID-19 pandemic; very few (4.9%) during the lockdown and the rest (23.4%) after lockdown. Median duration of suffering (before seeking healthcare) pre-COVID and during lockdown was 45 and 38 respectively, significantly increasing to 60 days ($p < 0.01$) post-lockdown.

Baseline characteristics of respondents:

From December 14, 2019, to September 5, 2020, out of 15,168 TB presumptives visiting the icddr,b TBSTCs of Dhaka, 1,571 were diagnosed with PTB, of whom 895

consented to participate in this study. **Table 1** shows that the majority of the participants were male (626, 69.9%) and hailed from urban areas (737, 82.3%). Their mean [±standard deviation (SD)] age was 36.6 ± 16.1 years, and their mean (±SD) Body Mass Index (BMI) was 20.1 ± 3.8 kg/m^2. Most of the enrolled participants were bacteriologically confirmed cases (868, 97%) and new cases (791, 88.4%). Few had a history of TB contact (33, 3.7%) or were relapse cases (104, 11.6%). Among the study respondents, 13.5% were illiterate, and 13.4% had studied beyond higher secondary. The majority had been educated up to the primary level (27.8%).

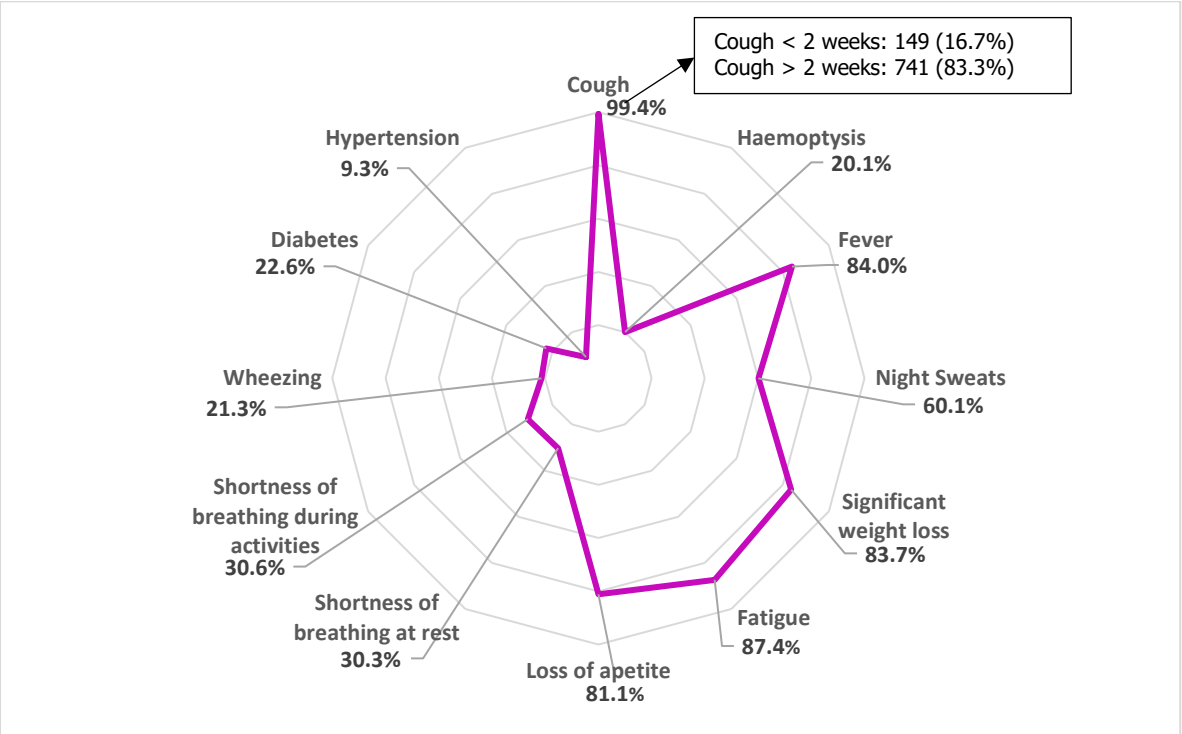
Table 1: Socio-demographic and nutritional profile

Characteristics		**Total (N = 895)**	
		n	**(%)**
Age (in years)	5–14	16	(1.7)
	15–24	257	(28.7)
	25–34	173	(19.3)
	35–44	151	(16.9)
	45–54	137	(15.3)
	55–64	103	(11.5)
	65+	58	(6.5)
Gender	Male	626	(69.9)
	Female	269	(30.1)
Educational status	Unable to read and write	121	(13.5)
	Primary (1–5)	249	(27.8)
	Junior secondary (6–8)	146	(16.3)
	Secondary (9–10)	151	(16.9)
	Higher secondary (11–12)	108	(12.1)
	Undergrad (13–16)	83	(9.3)
	Postgrad and above (>=17)	37	(4.1)
Marital status	Married	873	(97.5)
	Others	22	(2.5)
Living area	Urban	737	(82.3)
	Rural	158	(17.7)
BMI according to the World Health Organisation's Asian classification	Underweight (<18.5 kg/m^2)	317	(35.4)
	Normal (18.5–22.9 kg/m^2)	397	(44.4)
	Overweight (23.0–24.9 kg/m^2)	89	(9.9)
	Obese (≥25.0 kg/m^2)	92	(10.3)
TB case type	New case	791	(88.4)
	Re-treatment case	104	(11.6)
History of TB contact		33	(3.7)
TB diagnosis	Bacteriologically confirmed	868	(97)
	Clinically diagnosed	27	(3.0)

Most participants presented with the cardinal symptoms of cough (890, 99.4%), fever (752, 84.0%), significant weight loss (748, 83.7%) and night sweats (538,

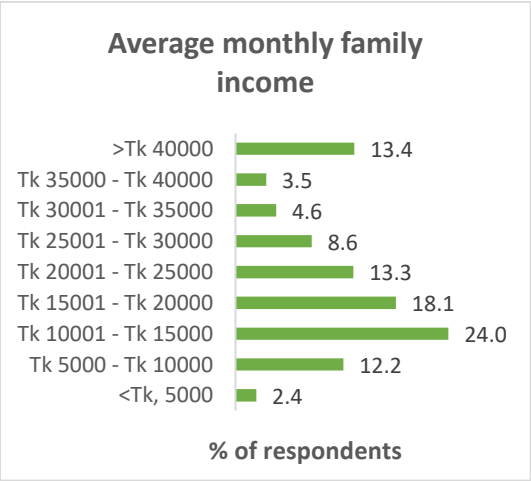
60.1%). The majority had a cough for over two weeks (741, 83.3%), as detailed within the clinical profile in **Figure 1**.

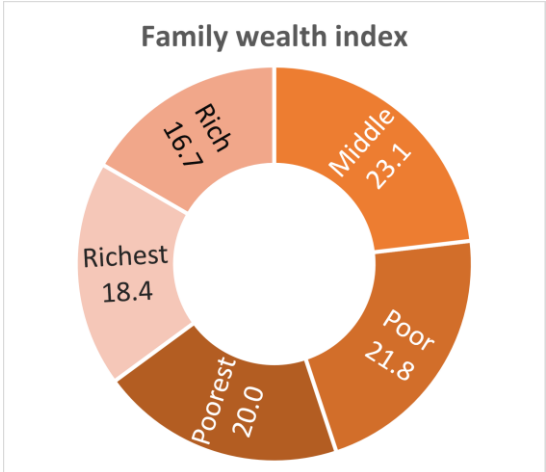
Figure 1: Clinical profile of the study participants with PTB (N = 895)



The highest number of participants had a family income of 10,001–15,000 Tk or 15,001–20,000 Tk, representing about one-fourth (24%) and one-fifth (18.1%) of the participants, respectively. The rest represented much lower percentages, as detailed in **Figure 2**. We also profiled the family wealth index of our respondents by a principal component analysis of their assets. This revealed that the participants' income levels were quite evenly distributed, though most came from the poor (21.8%) and middle (23.1%) wealth quintiles (9, 11).

Figure 2: Socioeconomic profile (average monthly family income and family wealth quintile) of study participants (N = 895)





Knowledge and awareness of TB:

Of 895 respondents enrolled, 95% (850) had heard about TB disease before, while 86.2% (733) were familiar with the symptoms before being diagnosed **(Table 2)**.

Table 2: Commonly known TB symptoms among the participants

	Total (N = 850)	
Commonly known TB symptoms*	**n**	**(%)**
Cough > two weeks	711	(97)
Fever > two weeks	526	(71.8)
Haemoptysis	313	(42.7)
Chest pain	305	(41.6)
Fatigue/anorexia	256	(34.9)
Unexplained weight loss	254	(34.7)
Evening rise of temperature	254	(34.7)
Respiratory distress	183	(25)
Night sweats	174	(23.7)
Headache	107	(14.6)
Numbness/tingling	102	(13.9)
Nausea/vomiting	74	(10.1)
Diarrhoea/constipation	26	(3.6)
Others (gibbous, joint pain)	3	(0.4)
Don't know	1	(0.1)

* Multiple responses allowed

Of the 850 respondents who had heard of TB, nearly two-thirds had heard of it through family and friends (519, 61.1%) and advertisements (518, 60.9%). Nearly 16% (133) did not know that TB could be transmitted through coughing, sneezing and shouting, while 11.8% (100) were under the misconception that TB was genetic. Two-thirds of the respondents (528, 62.1%) knew that TB can be contracted at any age **(Table 3)**.

Table 3: Participants' knowledge regarding the transmission of TB

	Total (N = 850)	
	N	**(%)**
Source of information on TB:*		
Family/friends	519	(61.1)
Advertisements	518	(60.9)
Doctor	292	(34.4)
Billboards	258	(30.4)
Cured TB patient	200	(23.5)
Health worker	182	(21.4)
Newspapers	158	(18.6)
Radio	133	(15.7)
Non-government organisation (NGO)	84	(9.9)
School	77	(9.1)
Others	14	(1.7)

	Total (N = 850)	
	N	(%)
One can get TB by:*		
Coughing, sneezing, shouting	697	(82)
Quick causal contact	346	(40.7)
Sharing utensils/food/drinks	280	(32.9)
Smoking cigarettes, biddi or tobacco	264	(31.1)
Exchanging saliva or other bodily fluids	219	(25.8)
Blood transmission	85	(10)
Changes in weather or cold temperatures	57	(6.7)
Others (e.g. air, genetic, dust, injection, low immunity)	14	(1.7)
Don't know	59	(6.9)
Patients with TB may prevent spreading it to others by:*		
Wearing a mask	666	(78.4)
Covering their mouth and nose when coughing or sneezing	447	(52.6)
Avoiding sharing utensils	398	(46.8)
Avoiding enclosed spaces when there are other people there	293	(34.5)
Avoiding shaking hands	230	(27.1)
Avoiding sleeping in the same room as other people	149	(17.5)
Not touching items in public places	90	(10.6)
Closing windows at home	53	(6.2)
Having good nutrition	39	(4.6)
Not having sex	37	(4.4)
Praying	26	(3.1)
Others (stopping smoking, opening the windows of the room, safely moving here and there)	5	(0.6)
Don't know	76	(8.9)
People affected by TB:*		
Men	701	(82.5)
Women	661	(77.8)
Elderly (>64 years)	599	(70.5)
Adults (15–64 years)	592	(69.7)
Children (<15 years)	583	(68.6)
Don't know	100	(11.8)

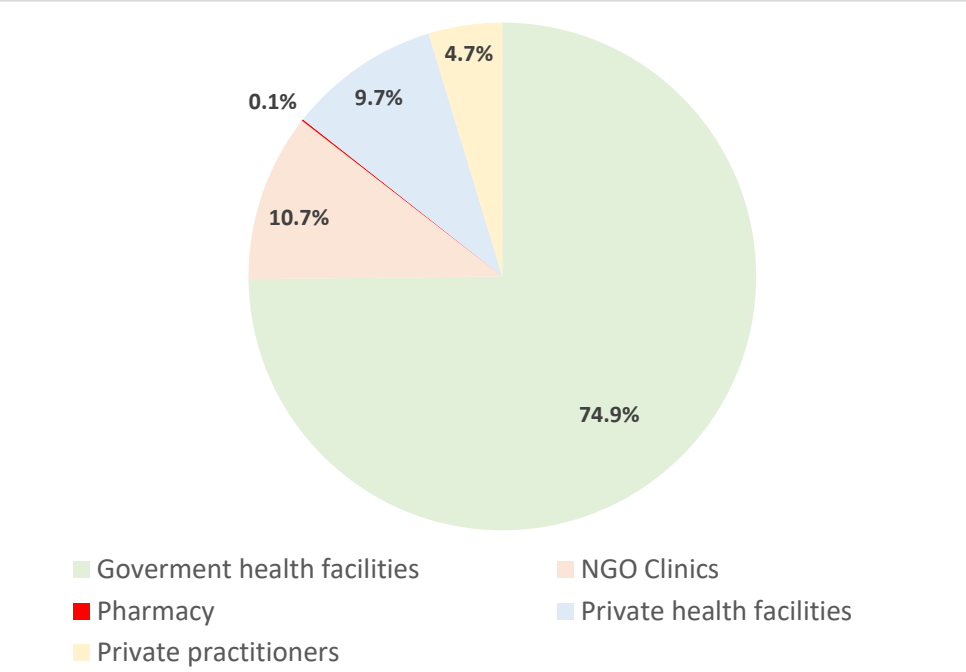
*Multiple responses allowed

The majority did not know the different types of TB (747, 87.9%), though some (60, 7.1%) knew there are two types. Only a few (31, 3.7%) could mention both PBT and extra-PTB, and half (442, 52%) mentioned only PTB. About one-fifth of the participants (162, 19.1%) did not know which organs could be affected by TB. The majority said the lungs (674, 79.3%), and others mentioned the abdomen (94, 11.1%), any part of the body (88, 10.4%), the lymph nodes (80, 9.4%), the bones (80, 9.4%), the meninges (70, 8.2%) and skin (67, 7.9%). During the interview, most (825, 96%) stated they had already been diagnosed with TB, of whom two-

thirds (516, 62.6%) were bacteriologically positive (512, 99.2%) or clinically diagnosed (4, 0.8%).

Two-thirds (512, 60.2%) of the respondents perceived that every person exposed to TB would become sick with it while one-third (238, 28%) did not think this was accurate, and one-tenth (11.8%) stated that they did not know. Most respondents (756, 88.9%) knew someone could become sick with TB again if they did not finish the full course of medicine. The majority (790, 92.9%) believed that TB can be fully cured. Most knew where to go if they thought they might have TB **(Figure 3)**.

Figure 3: Place to go if a patient thinks they may have TB (N = 817)



More than half of the participants thought TB is a very serious problem (522, 61.4%). The majority (711, 83.7%) correctly expressed that TB treatment is free of cost, 13.8% (117) stated they did not know the cost, and the remaining patients (22, 2.6%) thought TB treatment is costly. Their perceptions regarding TB treatment are given in **Table 4**.

Table 4: Participants' perception of TB treatment

	Total (N = 850)	
	N	**(%)**
Perceived benefits from starting treatment early and finishing the full course:		
Early cure	682	(80.2)
Less transmission	291	(34.2)
Fewer side effects	241	(28.4)
Shorter treatment time	204	(24.0)
Fewer complications	130	(15.3)

	Total (N = 850)	
	N	(%)
Less costly	118	(13.9)
Lower risk of drug resistance	84	(9.9)
Others (patient can do everything they could before, strength for work, make a better life)	3	(0.4)
Don't know	66	(7.8)
Perceived time taken to cure TB:		
6 months	657	(77.3)
12+ months	8	(0.9)
When the doctor tells me it is cured	6	(0.7)
When I feel completely better	5	(0.6)
Don't know	174	(20.5)
They heard about where to go from:		
Family/friends	483	(56.8)
Advertisements	386	(45.4)
Health worker	231	(27.2)
Cured TB patient	215	(25.3)
Billboard/signboard	209	(24.6)
Radio	127	(14.9)
Newspaper	126	(14.8)
NGO	95	(11.2)
Doctor	74	(8.7)
School	53	(6.2)
Others (self-known, word of mouth, history of TB)	16	(1.9)
Don't know where to go	13	(1.5)

*Multiple responses allowed

The mean of the calculated knowledge score (N = 850) was 32.2 ± 7.1 [median: 33 (29,37)]. The composite knowledge score of the patients was obtained by adding '1' if the response was correct for a query and '0' if the response was wrong. Upon categorising the total scores in percentile to reflect the levels of knowledge as inadequate (≤50%), moderate (51%–75%) and adequate (76%–100%), two-thirds of the patients (63.7%) had a moderate level of knowledge regarding TB **(Table 5)**.

Table 5: Knowledge score of enrolled participants (N = 850)

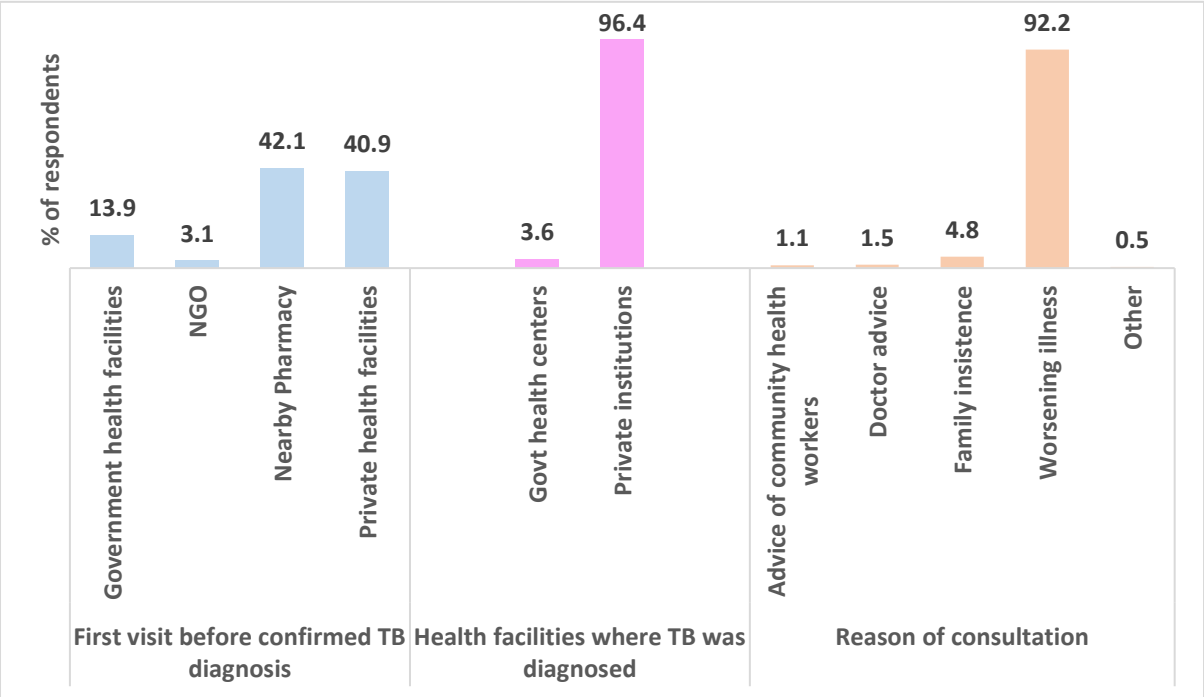
Knowledge score	Total participants		Level of knowledge	
(Total score = 50)	n	(%)	Percent score	Knowledge category
1–12.5	7	(0.8)	0–25	Inadequate
12.6–25	129	(15.2)	26–50	
25.1–37.5	541	(63.7)	51–75	Moderate
37.6–50	173	(20.3)	76–100	Adequate

*45 participants with 'no knowledge' were excluded from this scoring

Healthcare-seeking behaviour:

The study participants reported that their median (Q1, Q3) duration of suffering (before seeking treatment) was 45 (30, 65) days, while the median (Q1, Q3) duration of cough was 30 (20, 60) days. Two-fifths of the participants had their first visits at nearby pharmacies (377, 42.1%) or private health facilities (366, 40.9%). Most (825, 92.2%) visited due to worsening illness and were ultimately diagnosed at private institutions (863, 96.4%) (**Figure 4**). The median (Q1, Q3) time between the first care-seeking visit and the confirmed TB diagnosis was 28 (15, 55) days. Two-thirds of the participants (642, 71.7%) had a perceived delay in diagnosis – mostly because they hoped the symptoms would go away (82.5%) but also due to self-treatment (27.4%), shortage of money (21.7%), misdiagnosis (19.1%), seeking treatment from traditional healers (3.4%), social stigma (1.2%) and other reasons (4.5%).

Figure 4: Type of facility the study participants (N = 895) first visited, type of facility wherein their TB was diagnosed and reason for consultation



Access to health facilities:

A few respondents (35, 3.9%) said that the distance of the nearest health facility from their home was unknown to them, while the majority (860, 96.1%) reported that the mean (±SD) distance was 2.4 ± 2.4 km (Table 6). A few (33, 3.7%) did not know how long it took to visit the nearest health facility, but most (862, 96.3%) reported a mean (±SD) time of 20.3 ± 14.6 minutes. Most respondents (814, 90.9%) could also report the distance to the nearest DOTS centre, the mean (±SD) value of which was 2.5 ± 2.3 km (Table 6). The majority (815, 91%) reported that

the mean (±SD) time it took to travel there was 21.4 ± 13.8 minutes. Only a few (24, 2.7%) reported difficulties visiting DOTS centres for medication due to a long distance (14, 53.8%), time constraints (5, 19.2%), financial problems (4, 15.4%) or feeling too weak to travel (3, 11.5%). The median (Q1, Q3) transport cost to commute to and from the nearest DOTS centre to their residence was reported as an average of 1,200 (900, 1,800) Tk/month by the majority of respondents (812, 90.8%); the remaining few (82, 9.2%) said they did not know the cost. Moreover, 267 (29.8%) reported that their median (Q1, Q3) monthly wage loss would be 1,800 Tk (1,200, 3,500) if they had to travel to the DOTS facility for daily medication, 355 (39.7%) reported no wage loss, and 155 (17.3%) said that they did not know. Moreover, 118 (13.2%) respondents said wage loss was not applicable to them, as they were unemployed (69, 58.5%), homemakers (35, 29.7%), retired personnel (3, 2.5%), businessmen (2, 1.7%) or farmers (1, 0.8%). A few service holders (3, 2.5%) reported that they did not experience wage loss. Several (5, 4.2%) said that the DOTS centres were within walking distance, so they utilised their break times to go.

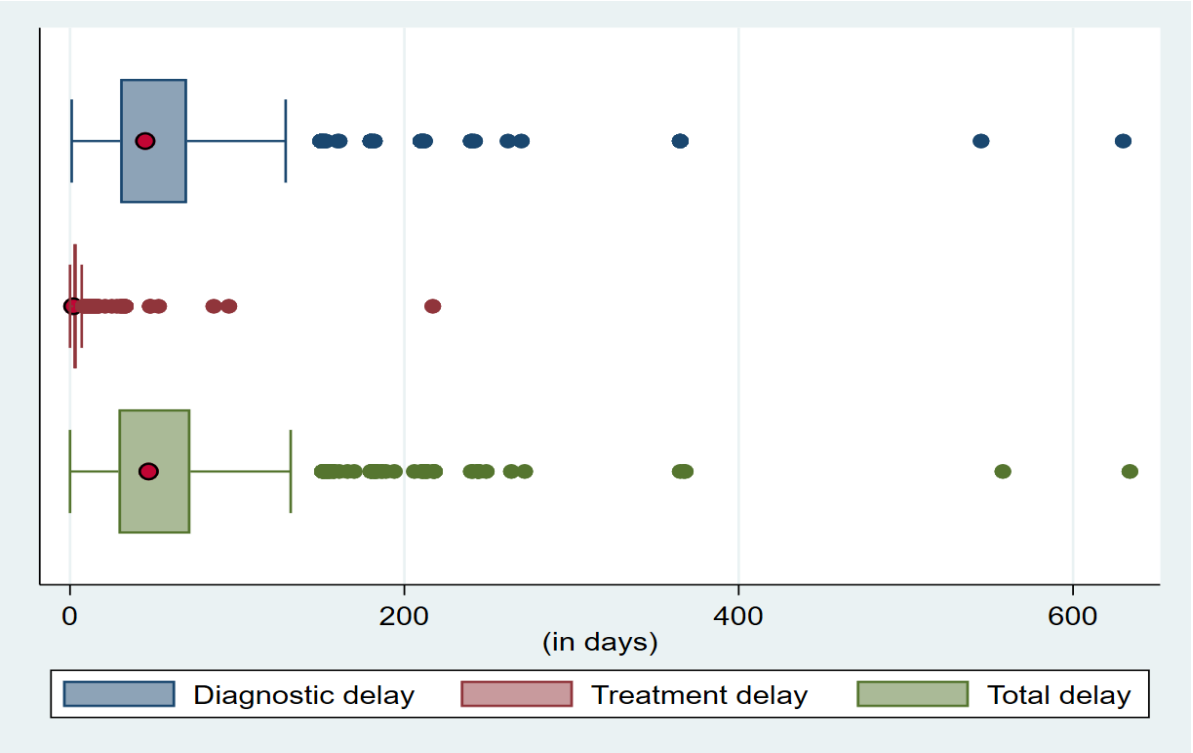
Table 6: Distance of visit from home to nearest health facility and DOTS centre

	Total (N = 895)	
	N	**(%)**
Distance between patient's home and nearest health facility		
Less than 5 km	765	(85.5)
5 to less than 10 km	79	(8.8)
10 km or more	16	(1.8)
Don't know	35	(3.9)
Distance between patient's home to DOTS centre		
Less than 5 km	709	(79.2)
5 to less than 10 km	94	(10.5)
10 km or more	11	(1.23)
Don't know	81	(9.1)

Delay in diagnosis and treatment initiation:

The median (Q1, Q3) delay in TB diagnosis (N = 867), considered from the symptom onset to the date of confirmed diagnosis, was found to be 45 (30, 70) days. The median (Q1, Q3) delay in treatment initiation (N = 883), considered from the date of confirmed diagnosis to DOTS enrolment, was found to be 2 (2, 4) days. The total patient delay was considered to be a combination of the diagnostic and treatment delays above, the median (Q1, Q3) of which was 47 (29, 72) days **(Figure 5)**.

Figure 5: Delay in diagnosis and treatment initiation (N = 895)



Regression analysis:

A patient usually seeks treatment within the 2–3 weeks of symptom onset; however, we added extra margin of 7 days to take 30 days as the cut-off to assess the magnitude of patient delay following most studies (12). Accordingly, out of the 895 respondents, over two-thirds (659, 73.6%) were found to have a delay in seeking treatment. **Table 7** shows the results of the univariate and multivariate logistic regression considering the above-mentioned cut-off value. Almost all indicators were crudely significant with delay. After adjusting the covariates, the likelihood of delay for patients with a cough >2 weeks was more than twice as high as that for the patients with a cough <2 weeks. Delay was less likely to occur among patients who reported night sweats. The odds of delay among patients who had diabetes were twice as high as that of those who did not. The odds of delay among patients who were bacteriologically positive were 3.7 times higher than those of patients who were clinically diagnosed. The patients who had self-treatment were twice as likely to delay than those who did not.

Table 7: Univariate and multivariate logistic regression for measuring the predictors of delay

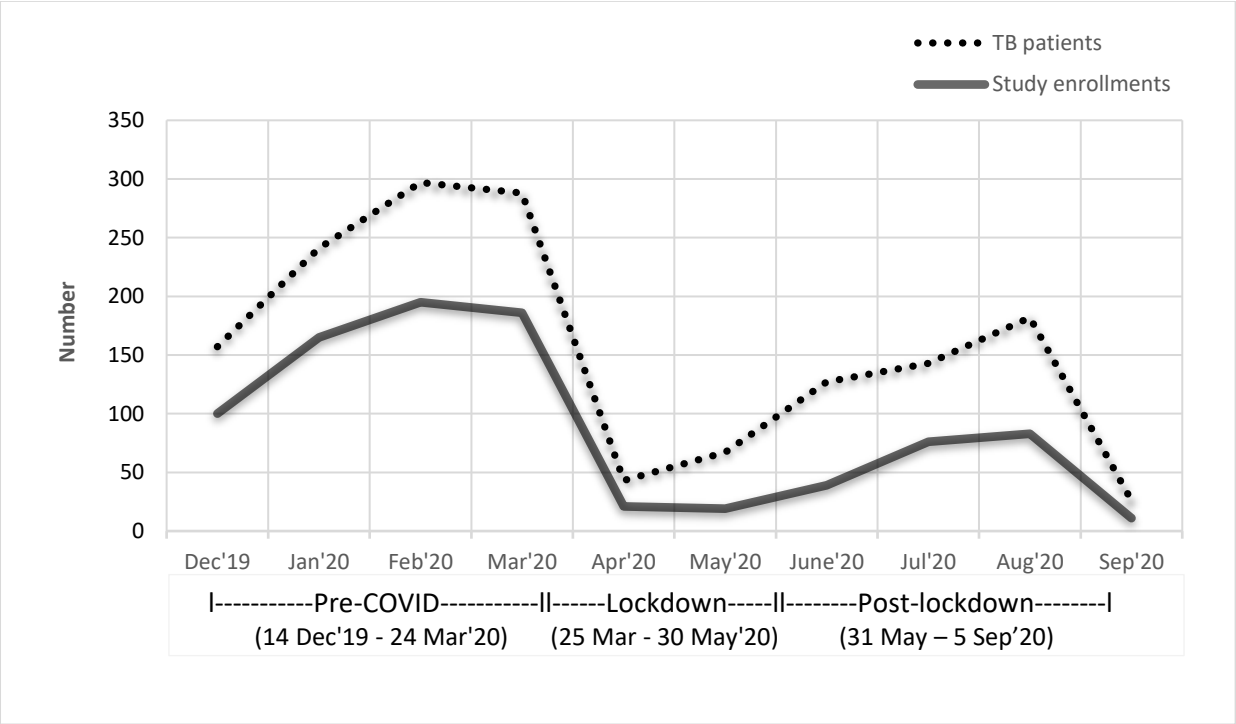
Covariates	Crude OR (95% CI)	Adjusted OR (95% CI)
Age in years	1.01 (1–1.02)*	1.0 (0.98–1.01)
Cough duration in days	1.02 (1.02–1.03)*	1.0 (1–1.01)
Cough >2 weeks (Reference: ≤2 weeks)	3.37 (2.34–4.86)*	2.44 (1.39–4.27)*

Night sweats (Reference: no)	0.67 (0.49–0.92)*	0.55 (0.34–0.84)*
Wheezing (Reference: no)	1.58 (1.07–2.33)*	1.25 (0.75–2.09)
Diabetes (Reference: no)	1.73 (1.17–2.55)*	1.95 (1.11 – 3.42)*
Education (Reference: unable to read and write)		
Primary	0.94 (0.55–1.61)	1.16 (0.56–2.4)
Junior secondary	0.76 (0.42–1.36)	0.94 (0.41–2.13)
Secondary	0.58 (0.33–1.03)	0.78 (0.35–1.76)
Higher secondary	0.48 (0.26–0.86)*	0.44 (0.19–1.05)
Undergrad	0.42 (0.22–0.78)*	0.56 (0.23–1.38)
Postgrad and above	0.59 (0.25–1.35)	0.58 (0.17–1.93)
Marital status (Reference: single)		
Married	1.66 (1.22–2.27)*	1.35 (0.77–2.36)
Widow	3.05 (0.67–13.89)	1.75 (0.22–13.8)
Area of living (Reference: rural)	0.52 (0.33–0.81)*	0.61 (0.33–1.15)
Patients knew about TB symptoms before being diagnosed (Reference: did not know)	1.06 (1.01–1.1)*	1.03 (0.95–1.11)
TB can affect people of any age (Reference: no)	1.08 (1.01–1.16)*	0.99 (0.88 – 1.11)
First visit before confirmed TB diagnosis (Reference: government health facilities)		
NGO/NGO clinic	1.15 (0.47–2.83)	2.49 (0.79–7.85)
Nearby pharmacy	1.98 (1.25–3.13)*	1.51 (0.78–2.92)
Private health facilities	0.96 (0.62–1.49)	1.78 (0.94–3.37)
Time between first visit and confirmed diagnosis	1.1 (1.08–1.12)*	1.09 (1.07–1.11)*
Type of TB patient (Reference: pulmonary CD)	3.13 (1.45–6.77)*	3.7 (1.31–10.46)*
Delay in diagnosis (Reference: no)	6.48 (4.67–8.99)*	1.7 (0.76–3.80)
Hoped symptoms would go away	3.66 (2.68–5)*	1.19 (0.57–2.49)
Shortage of money	2.28 (1.40–3.72)*	0.94 (0.49–1.82)
Self-treatment	2.69 (1.70–4.26)*	2.05 (1.09–3.88)*
Misdiagnosis	3.48 (1.92–6.3)*	2.03 (0.93–4.42)
* refers to significance considering $p < 0.05$		

Effect of COVID-19:

Data from various countries and modelling studies from 2020 have highlighted that the COVID-19 pandemic has dramatically impacted the TB case detection and management (13-17). It had impacts on people affected by TB and their communities, exacerbating existing challenges around TB programs worldwide and setting back efforts to reach the targets set at the United Nations High Level Meeting in 2019. As for our study, COVID-19 challenges considerably reduced the number of enrolments. We enrolled the majority of participants (642, 71.7%) before the countrywide lockdown (14 December 2019 to 24 March 2020), very few (44, 4.9%) during the lockdown (25 March 2020 to 30 May 2020) and the rest (209, 23.4%) after the lockdown (1 June 2020 to 5 September 2020), corresponding with the waning number of presumptive cases attending the TBSTCs **(Figure 6)**.

Figure 6: Enrolment of study participants (N = 895) from December 2019 to September 2020 at the icddr,b TBSTCs



We also analysed the data to show the effect of COVID-19 on the healthcare-seeking behaviour of patients with TB before, during and after the lockdown in Bangladesh. The median cough duration (30 days) increased alarmingly post-lockdown [60 days, inter-quartile range (IQR): 69, $p < 0.01$], but fewer patients presented with fever (74.6%, $p < 0.01$) post-lockdown than during lockdown (86.4%) and pre-COVID (86.9%) phases. The median duration of suffering (before seeking healthcare) pre-COVID and during lockdown was 45 (IQR: 35) and 38 (IQR: 43) days, increasing to 60 days (IQR: 60, $p < 0.01$) post-lockdown. The majority of patients visited due to worsening illness, especially post-lockdown (96.7%, $p < 0.01$). Pre-COVID, the first visits were to nearby pharmacies (40.3%), followed by private health facilities (20.6%), which reversed (pharmacies: 20.5%; private health facilities: 43.2%) significantly during lockdown ($p < 0.01$), returning to 45.5% and 17.2%, respectively, post-lockdown. The median time between the first visit and confirmed diagnosis (27 days) increased post-lockdown (30 days, IQR: 45, $p < 0.05$). Most participants' (71.7%) perceived that a diagnostic delay occurred while they were hoping that symptoms would subside (80.2% pre-COVID vs 87.6% post-lockdown, $p < 0.05$) and were taking self-treatment (25.9% pre-COVID vs 34.2% post-lockdown, $p < 0.05$).

Qualitative findings – patient delay

Key Qualitative Findings for Patient delay
▪ Some participants had preliminary/basic knowledge about TB ▪ A significant number of participants usually visited local pharmacies as first point of contact with complaints of cough, fever and chest pain, whereas some participants started their initial treatment from quack doctor or huzur (spiritual healer) ▪ A significant number of participants perceived that they were given the wrong treatment on their first visit ▪ A few participants mentioned the challenge of collecting medicine on time as a reason of delayed initiation of medication ▪ COVID-19 emergency situation was also reported as one of the significant reasons of delay in diagnosis and treatment initiation

Demographic information:

- Among the 21 IDI participants, 13 were male (62%).
- Two study participants (2/21) suffered from TB disease before this episode. One was diagnosed with TB one year ago, and the other suffered from TB four years ago.
- The median (Q1, Q3) age of the participants was 35 (22, 51).
- Most participants received Class VI to Secondary School Certificate or below education, and two did not have any institutional education.
- More than half of the participants (12/21) were earning members (e.g., service-holders, businessmen, garment workers, farmers or day labourers), and the remaining were students and homemakers.

Perceived knowledge of TB disease:

Most of the participants (17/21) had some level of knowledge of TB. Among them, four informed us that TB is transmitted through coughs, sneezes and food shared from a patient with diagnosed confirmed TB, and three said that TB usually affects the lungs but can also affect other parts of the body. A few participants (3/21) mentioned that they obtained this information from television advertisements and billboards installed on hospital premises.

A 35-year-old male participant stated,

> 'I had been having **[a]** cough for at least two–three months, but it did not contain any sputum or blood. I thought the cough might have been caused by dust'.

Health-seeking behaviour:

Most of the participants (12/21) first visited local pharmacies with complaints of cough, fever and chest pain, while two participants started their initial treatment from Quack and Huzur. Almost all participants (19/21) stated that they only visited formal physicians when their physical condition worsened. Among them, two mentioned that they visited the doctor because of family pressure. Most participants (17/21) were diagnosed with TB at icddr,b TBSTCs, and the rest were diagnosed at different public hospitals and private diagnostic centres. Seven participants initiated treatment from nearby hospitals or clinics, while the remaining ones received treatment from the icddr,b TBSTCs wherein they were diagnosed.

A 50-year-old male participant said,

> 'I started taking medicine from [the] pharmacy after 7 or 15 days of getting [a] fever and cough. But the medicine was not working; then, I went to the hospital'.

About half of the participants (10/21) had a coughing history of more than two months. Five had a history of cough with fever for more than one year, and four had a history of cough with fever for more than one month.

A 50-year-old male participant said,

> Some of my family members suggested [that I take] medicine and see if those works, else I would die. As I didn't know what was affecting me, I took medicine. But my situation did not improve, and then I visited a doctor.

One-third of the participants (7/21) stated that due to their economic insolvency, they delayed seeking healthcare. According to the participants, their income ranged between 5,000 and 10,000 Tk per month. Their financial hardships also prevented them from taking treatment from renowned doctors.

A 56-year-old male participant expressed,

> Due to my insolvency, I have been suffering from this sickness for two months. Many people, including my wife and son, asked me to visit a doctor. But it takes money to go to [a] doctor; if I [had] had money, I wouldn't have delayed the treatment for two months.

One-fourth of the participants (5/21) stated that their treatment initiation was delayed due to their negligence.

A 50-year-old male participant stated,

> 'It would have been better if I could have reversed my earlier actions. As I told… I delayed because of my laziness'.

A few participants (3/21) thought they were suffering from seasonal fever and cough and were not worried about it. Two participants mentioned that their treatment initiation was delayed due to personal reasons; one was occupied with attending an exam, and the other could not take leave from their office.

Perceived reasons for diagnostic delay:

Most of the participants (18/21) perceived that they were given the wrong treatment on their first visit.

A 51-year-old female participant said,

> 'No remarks on the doctors' failure! They could not diagnose the disease in spite of having such valuable degrees. We suffered and wasted money'.

One-fourth of the participants (5/21) mentioned that they were diagnosed 'negative' via a cough test (sputum smear microscopy and GeneXpert) for their first diagnosis. Among them, three were reported to be GeneXpert negative. The gap between two tests was 4–5 days. According to the participants, their diagnosis was delayed because they tested positive in the first test but negative in subsequent tests.

A 28-year-old male participant stated,

> I tested at the Rampura TBSTC, and the result came [back] positive. Then, I showed the report to a doctor at Bangabandhu Sheikh Mujib Medical University. Upon my brother's request for [a] medicine prescription, the doctor responded that he could not prescribe any medicine without tests and suggested additional tests. This time the test report (GeneXpert) came [back] negative. The doctor did not prescribe any medicine but suggested to observe my fever with a thermometer and other relevant symptoms. He later recommended me to visit a respiratory specialist, and I complied.

One-third of the participants (6/21) delayed collecting their investigation reports, including their sputum test, GeneXpert test and chest X-ray. One participant collected his report 11 days after the collection date due to family issues and the long distance from his hometown to Dhaka. Another collected their report 14 days after the assigned date due to forgetfulness. The remaining four collected their reports after a three-day delay.

Perceived reasons for treatment delay:

A few participants mentioned (2/21) that they delayed starting their medication because they struggled to collect the medicines on time. Both participants came to Dhaka for their treatment. When they were diagnosed with TB, they decided to obtain the prescribed medicines in their hometown. One participant mentioned that he could not return to his hometown due to the COVID-19 lockdown, so he could not collect the prescribed medicines on time. He started taking the medicine seven days after being diagnosed. The other participant said that after returning from Dhaka, he could not leave his house due to severe sickness and, thus, could not collect the medicines on time. Therefore, he started taking the medicine six days after his diagnosis.

Delay in diagnosis and treatment initiation due to the COVID-19 situation:

Due to the COVID-19 emergency, a few participants (3/21) suffered while the lockdown was in place; PPs were unavailable and the movement restrictions caused the patients to delay their treatment.

One 18-year-old male participant said,

> 'It was tough for us to move outside home as there were lockdown[s] in force, so we could not move to [the] hospital. I suffered a lot as I had high fever with fatigue'.

Findings for acceptability of Janao

From August 2020 to March 2021, a total of 223 doctors and 94 DOT providers consented to participate in our study on the acceptability of Janao.

Key Quantitative Findings for Acceptability of Janao

- ***Notification by doctors:*** The median number of TB patients diagnosed by the doctors after registering with Janao was 20. During the same period, the median number of TB patients notified by the doctors through Janao was 5.
- ***Notification by DOT providers:*** The median number of TB notification received by the DOT providers after registration with Janao was 21.5. During the same period, the median number of TB patients enrolled through Janao by the DOT providers was 11.5.
- ***Doctors' engagement with the application:*** Most of the doctors (80.3%) expressed that the Janao application is a good way to notify TB patients. Most of them (88.3%) expressed that the application should be used by every physician diagnosing TB patients.
- ***DOT providers' engagement with the application:*** Most of the DOT providers (91.5%) opined that Janao application is a good way to notify TB patients. Majority (96.8%) of the DOT providers opined that the application should be used by all DOT facilities enrolling TB patients.

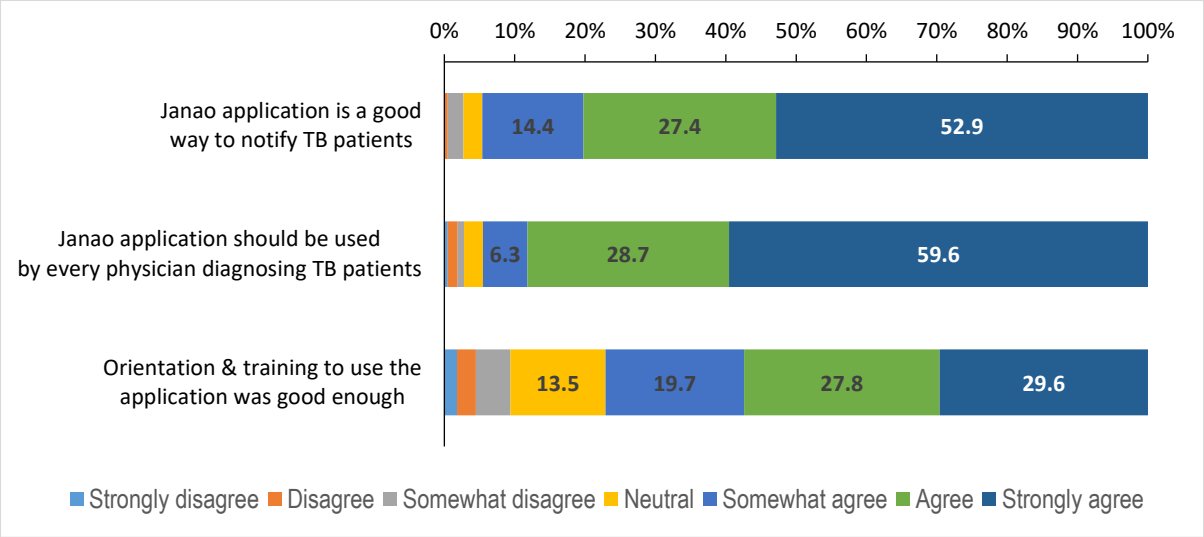
Findings from doctors:

Table 8: Basic characteristics of the engaged doctors

Characteristics	Total (N = 223)	
	n	(%)
Age (mean ± SD)	44.9 ± 9.7	

Characteristics		Total (N = 223)	
		n	(%)
Gender	Female	31	(13.9)
	Male	192	(86.1)
Diagnosed TB patients, median (IQR)		20 (41)	
Notified TB patients, median (IQR)		5 (8)	
Minutes taken to notify a TB patient using Janao (mean ± SD)		4.4 ± 2.4	

Figure 7: Doctors' engagement with the application



Figures 7–10 depict the Likert scale findings on the doctors' acceptability of the Janao app. Most of the responses in the figures are prominently inclined towards the right, i.e. the 'Strongly agree' option (except one in **Figure 10**, which is inclined towards the left, i.e. the 'Strongly disagree' option) for the statement 'There were some difficulties using the application'. The responses to the statement in **Figure 10** 'The application should be used by a larger group of users' were the one most inclined towards the right, indicating a positive recommendation by most of the users. In addition, in **Figure 7**, the statement 'Orientation & training to use the application was good enough' was not as inclined to the right as most other responses, which indicates the users' need for training. **Figure 11** summarises and shows the responses to the question on the most difficult portion(s) of the application in percentages.

Figure 8: Ease of use of the application for the doctors

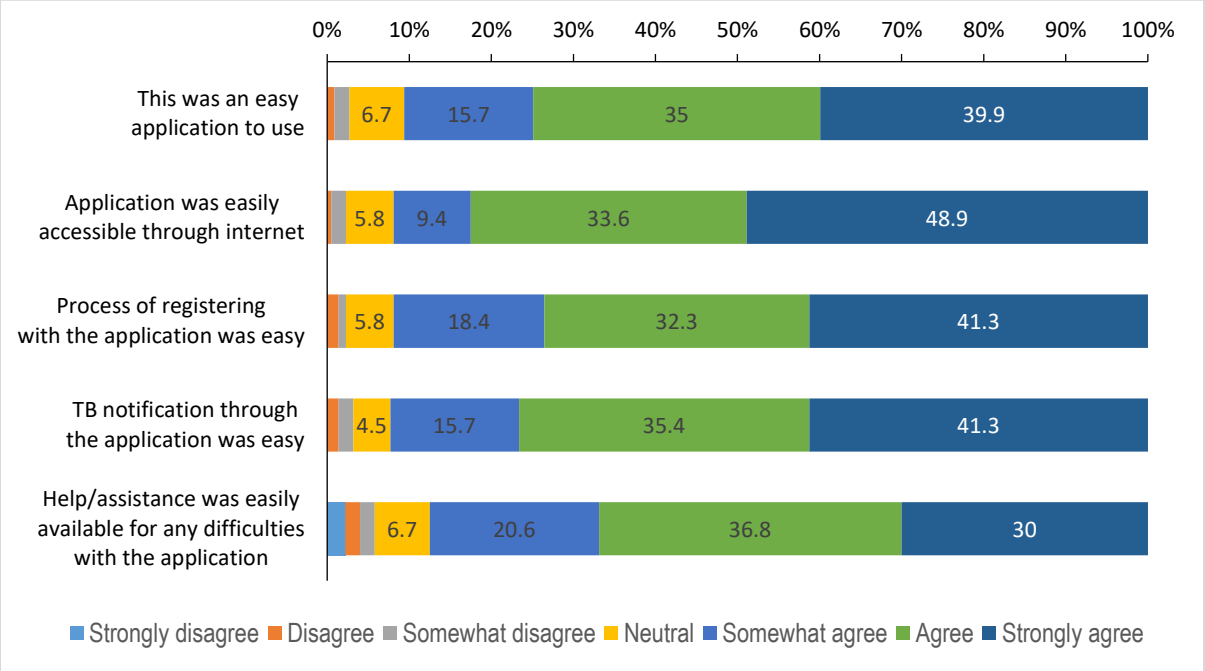


Figure 9: Usefulness of the application for the doctors

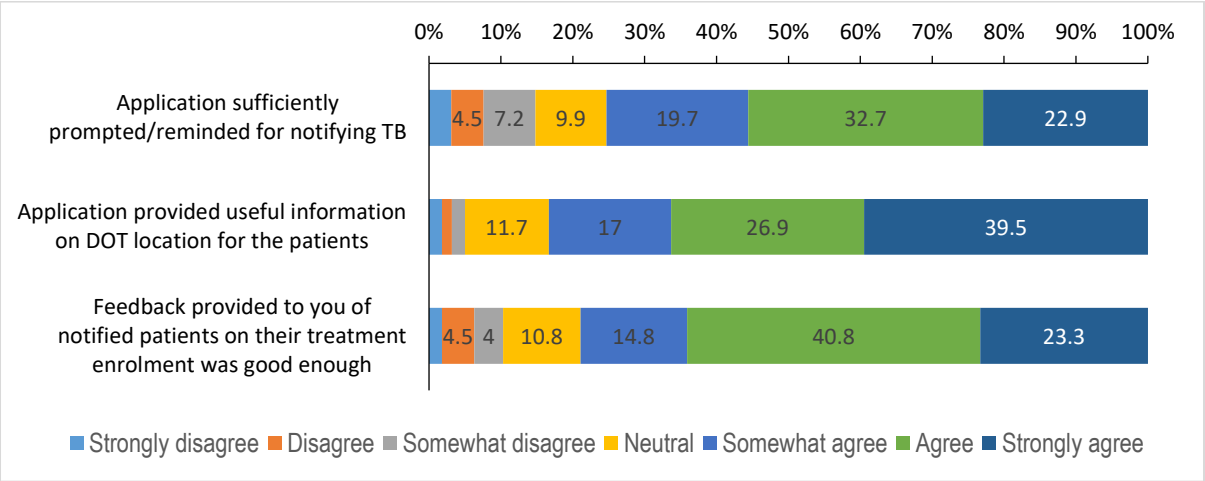


Figure 10: Difficulties with the application for the doctors

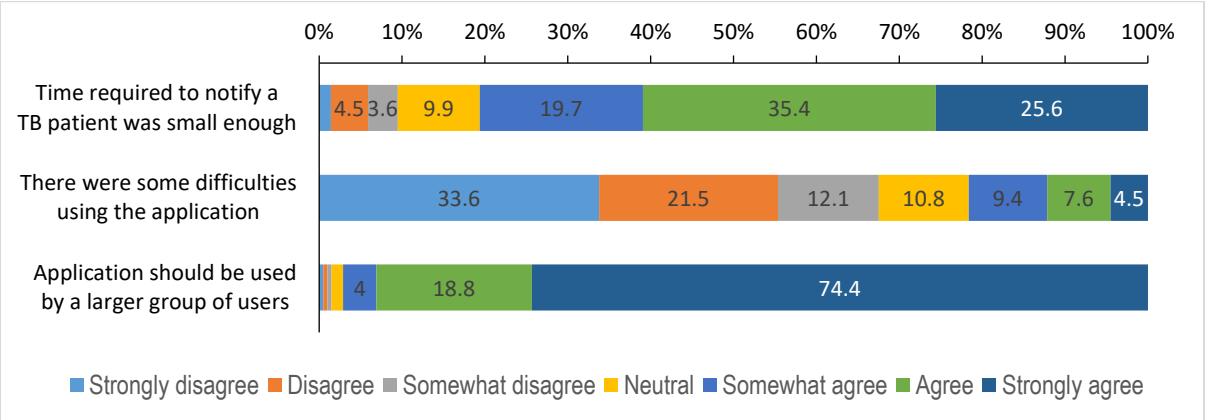
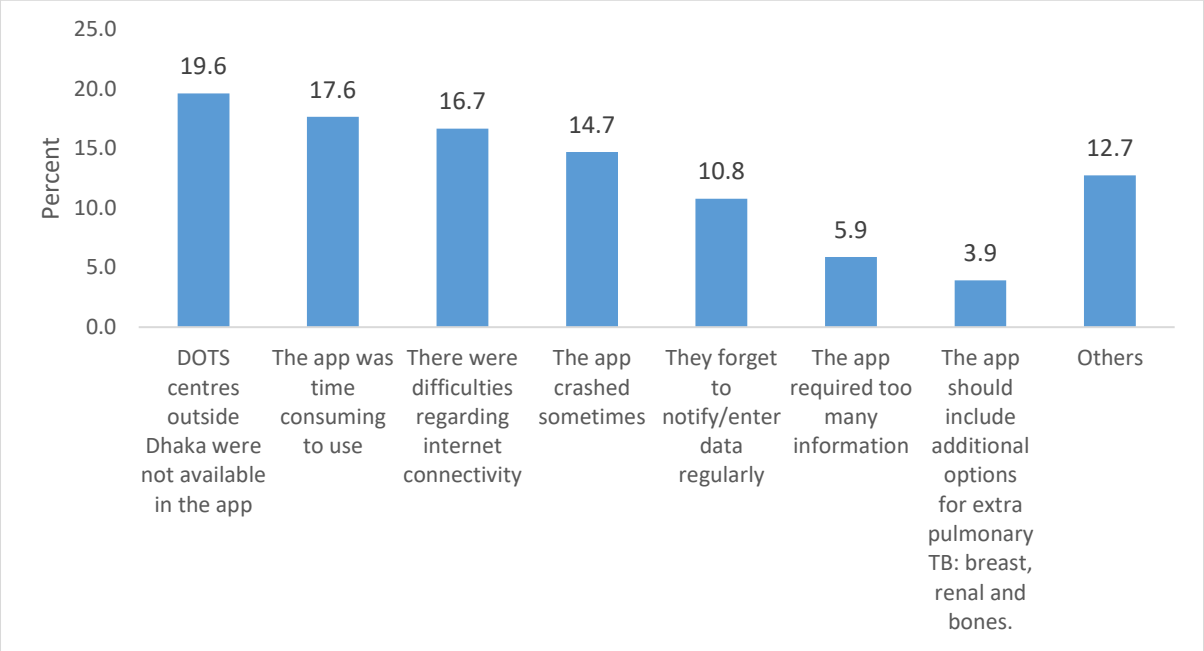


Figure 11: Most difficult part of using the app for the doctors (N = 101)



Findings from DOT providers:

Table 9: Basic characteristics of the engaged DOT providers

Characteristics		Total (N = 94)	
		N	(%)
Age (mean ± SD)		34.4 ± 8.6	
Gender	Male	42	(44.7)
	Female	52	(55.3)
Received TB patient notification, median (IQR)		21.5 (23)	
Enrolled TB patients for treatment, median (IQR)		11.5 (15)	
Minutes taken to communicate about a TB patient using the Janao app (mean ± SD)		4.0 ± 4.0	

Figures 12–15 depict the Likert scale findings on the DOT providers' acceptability of the Janao app. Most of the responses in the figures are prominently inclined towards the right, i.e. the 'Strongly agree' option (except one in **Figure 15**, which is slightly inclined towards the left, i.e. the 'Strongly disagree' option) for the statement 'There were some difficulties using the application'. In **Figure 15,** the responses to the statement 'The application should be used by a larger group of users' are primarily inclined towards the right, indicating a positive recommendation by most of the users. **Figure 16** summarises and demonstrates the responses to the question on the most difficult portion(s) of using the application in percentages.

Figure 12: DOT providers' engagement with the application

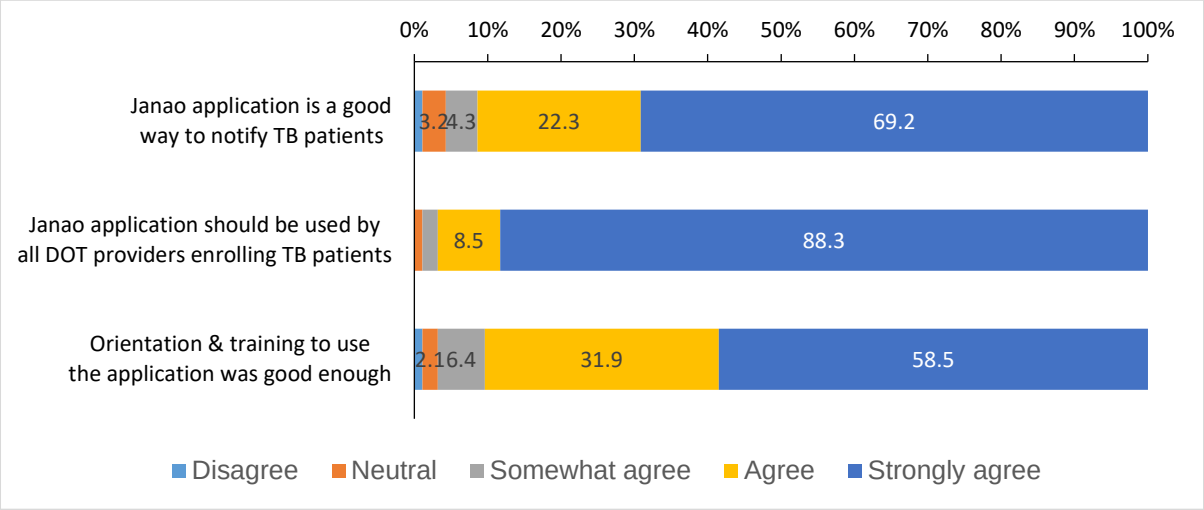


Figure 13: Ease of use of the application for the DOT providers

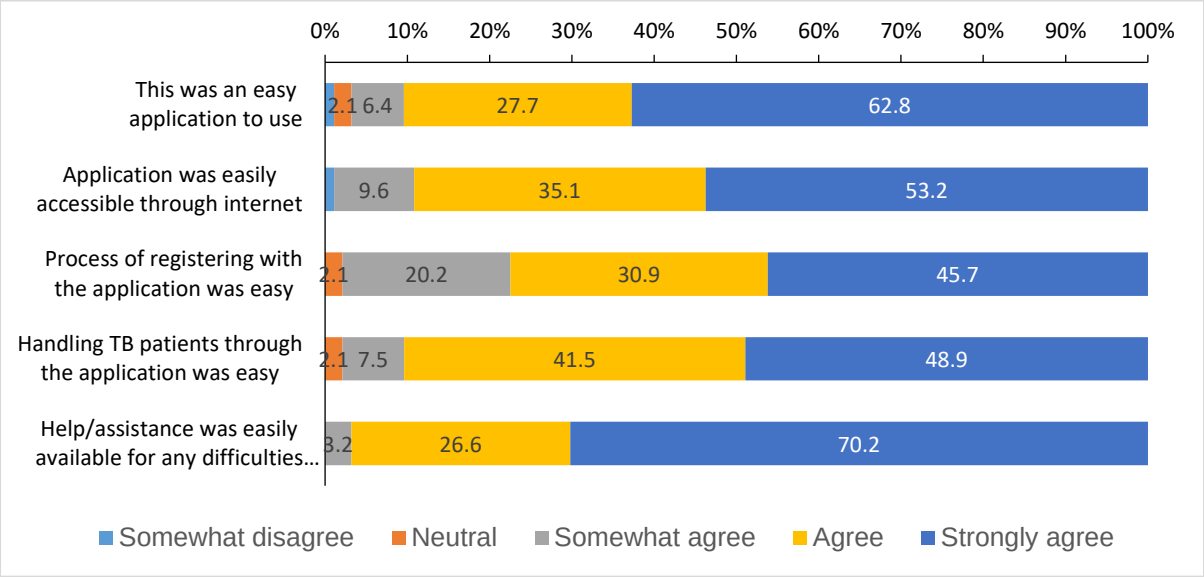


Figure 14: Usefulness of the application for the DOT providers

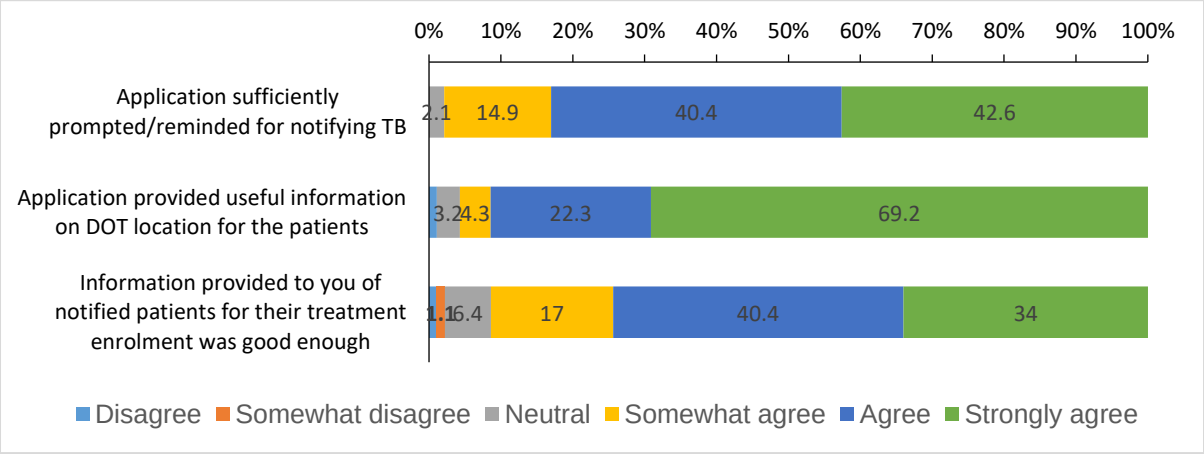


Figure 15: Difficulties with the application for the DOT providers

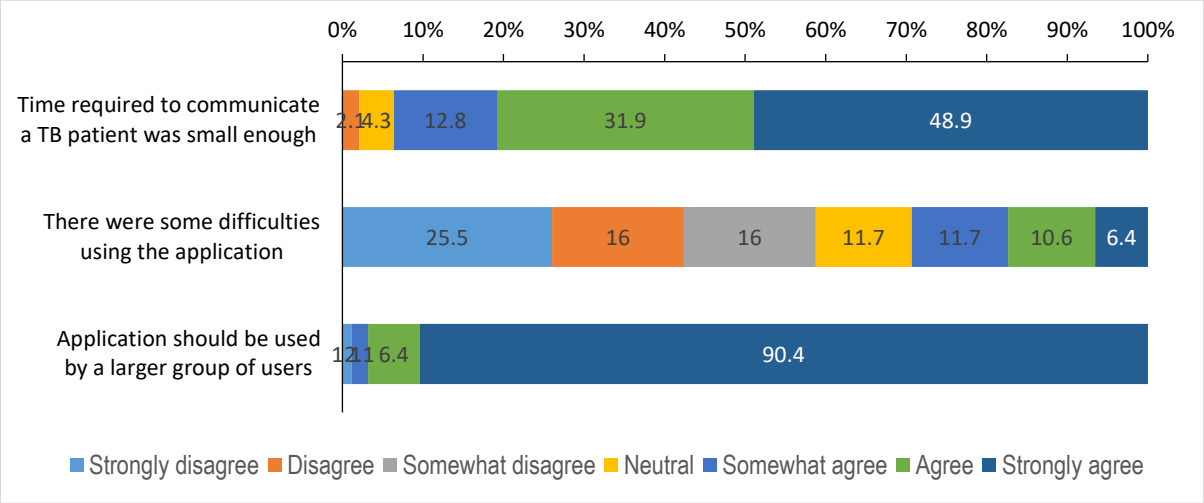
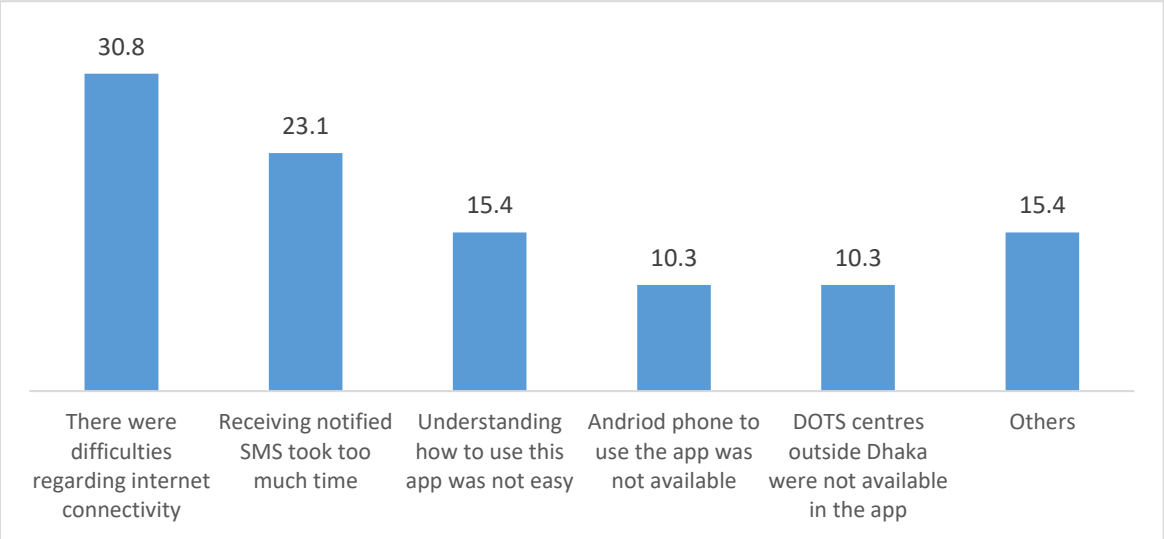


Figure 16: Most difficult part of using the app for DOT providers (N = 39)



Qualitative findings – Acceptability of Janao

Key Qualitative Findings for Acceptability of Janao
• Participants noted that easy access to the app, easy registration system, quick tracking mechanism and availability of technical help contributed to the app's acceptability for TB notification and treatment enrolment. • Availability of information, receiving necessary feedback and sufficient reminder for notifying TB patients contributed in the interest to use Janao app. • The app was reported to be slow sometimes to upload patient information. In addition, almost all of the doctors said that patient outcomes were not available on the app and suggested adding this feature.

Key Qualitative Findings for Acceptability of Janao
• More training/orientation sessions were suggested by the participants to increase usage of the app • Lack of technical knowledge and/or financial limitations of DOT providers in using smartphones/internet worked as a barrier to receive/manage notifications by Janao app

Demographic information:

We conducted a total of nine interviews with the doctors who diagnosed patients with TB and seven interviews with DOT providers. The mean age of the doctors was 46 years, and that of the DOT providers was 35 years. All doctors had Bachelor of Medicine and Bachelor of Surgery (MBBS) or higher degrees, and the DOT providers' education ranged from the three-years bachelor degree to master degree. The mean work experience of the doctors and DOT providers comprised 21 and 7 years, respectively. Eight of the doctors were males.

The number of confirmed/diagnosed TB cases:

The majority of the interview respondents (4/9) stated that they usually spent 30 days on patients' treatment, which was 26 days, excluding the weekends, for the rest. One respondent said that on an average, they investigated 10 patients with presumptive TB per week, among whom 2–3 patients were confirmed to have TB. Another respondent said that he never kept the count of confirmed TB patients against the presumptive TB patients that he had attended. Another respondent said that per month, he investigated 7–8 patients for TB, and almost all of them were diagnosed with the disease.

One 56-year-old male doctor said,

> 'I prescribe TB medicines for 1–2 patients in my practice daily, either pulmonary or extra-pulmonary. That makes around 20 to 30 patients in 20 days'.

Perceived advantages of using the Janao application for diagnosing and treating TB patients:

Three doctors said that there were no added advantages in diagnosing patients using the app. For example, if they wanted to diagnose a patient, they would not find any relevant information in the app. However, for treatment, they said that the app was revolutionary. One doctor said that after diagnosing a patient, they register patients and send them to eligible DOTS centres. The patients can easily pick up

their medicine from the assigned centres and maintain their medicine schedule. Most importantly, the patients' medication start date can also be seen in the Janao app. Two respondents said the Janao app had advantages in tracing patients. Earlier, they could not determine whether their patients had started their medicine, but with the aid of this app, they could easily check whether their patients were connected with a DOTS centre.

One 63-year-old male doctor said,

> 'It's a good national network to communicate with the authority and patients'.

Another respondent said that through this app, they can ensure that 100% of the patients are receiving treatment. However, one doctor said that a limitation of the app is that it does not include patients outside Dhaka. He mentioned that many patients come from outside the city but that doctors cannot trace whether those patients have started their medicine, as the app does not show information for them. The DOT providers said that with this app, tracing TB patients from the providers' end and initiating treatment from the patients' end have become much easier. Previously, patients did not have much idea on treatment availability after getting diagnosed with TB. Some patients did not initiate treatment due to lack of counselling.

A 27-year-old male provider said,

> 'Now, we can track TB patients and could contact them easily. The treatment initiation would have been delayed if we had not had the mobile phone numbers from the app'.

Easy to refer patients to other health centres:

The DOT providers reported that patients could easily be referred from one centre to another based on their preference using the app. The updated information could be easily viewed in Janao.

A 31-year-old female provider said,

> We can easily refer a patient to another area beyond ours; it's a great advantage. I called a patient over [the] phone and found that he already [had] started medicines from another centre. Using the app, I then referred the patient there easily.

Perception of the user-friendliness of the app:

Two out of the eight doctors reported that using the app was time-consuming at the beginning and that it took a long time to register patients. One doctor reported that they complained during the training and that the app was later updated and the problem resolved; it then took a maximum of two minutes to register a patient. One respondent also said that they were sending patients to DOTS centres through this app and that the patients could easily collect medicines from there. One respondent

said that Janao is a user-friendly app without mentioning a preference for any specific part of it.

A 41-year-old male doctor said,

> Most importantly, when we enter the address of the patient, we can see all [of] the nearby centres, which we might not know otherwise. We might know about a few centres, but with the help of the app, we can locate all [of] the nearby centres.

Another doctor said that the app was very user-friendly. Anyone who can browse the internet can easily operate the app. Most importantly, there is a Bengali font in the app, and even older doctors can use it without issue. However, 50% of the doctors said that they needed to be sensitised to increase use of the app.

The DOT providers also said that the patient enrolment seemed easy using the app and that they did not face troubles enrolling patients with TB, which took only 1–2 minutes. It would have taken much longer doing so manually. They could also get patients' names and contact numbers from the app notifications. A 27-year-old male provider said,

> It can be easily used; just by tapping over the notification list, we can see the patient's name and number. Then, we can easily contact them. Just we need to enter the TR (treatment registration) number and submit it – that's it.

Perceived challenges with the app:

Three respondents stated that they perceived the app to be too slow to upload patient information. In addition, almost all of the doctors said that patient outcomes (e.g. cured/relapsed/died) were not available on the app and suggested adding this feature.

A 63-year-old male doctor said,

> 'I have not thought specifically [about] what is the disadvantage or what I least like about the app; however, patient follow-up after finishing [a] drug or cure or expiration should also be seen through this app'.

Two doctors informed us that the app should be made more precise to reduce the time needed to insert patient information. Another respondent said he could not use the app due to his patient load, so he instructed his assistants to use it instead.

A 44-year-old male doctor said,

> 'Sometimes, I had 3–4 patients waiting outside my chamber; some of them could have been TB patients, too, so what should I do then? Should I attend the waiting patients or fill out the app? It's a problem'.

Four doctors said that the only disadvantage of the app was that it required an internet connection and took too much time to load. Another respondent said that

having stable internet connectivity was an important issue. One doctor said that they tried to synchronise the information in the app but failed, and another said that the app often froze during use. The DOT providers also stated that they did not have an internet connection stable enough to use the app, meaning they could not register patients. They had to spend their own money to purchase internet bundles. Sometimes, it was necessary to refer patients to other centres using the app. A 46-year-old male doctor said,

> 'When we go for synchronising, this app instructed us to try again later. This has become a very common problem nowadays'.

Two respondents mentioned that the location should be precisely indicated in the app. One respondent said that when he tried to search centre locations in Dharmapasha and Dhirai Upazilas of Sunamganj District, he found locations in the Osmani Medical College Hospital and North Eastern Medical College of Sylhet District. He asked,

> 'Is it possible for my patients to move to Sylhet DOTS from Sunamganj District?'

In addition, one DOT provider said the patients were disturbed if called frequently for the follow-up and that the doctors often forgot to register patients in the app and verbally inform them about the DOTS centres. Some DOT providers mentioned that a smart phone was required to use the app; some of them lost or damaged their phones, so they could not register patients with TB.

A 46-year-old female provider said,

> 'My mobile phone got snatched thrice. We cannot use the app without [a] smart phone; I could not register patients in the app for three months. I cannot afford to buy a mobile phone worth 16–17,000 Tk'.

Specific aspect of the application most liked by the users:

One respondent said that he liked the feature - patient's location information is sufficient to find all nearby centres. He found it to be a unique feature of Janao. Another respondent found the novel feature of tracking patient by the app to be their preferred aspect, as prior to launching this app, following up on a patient's treatment initiation was not possible. Another respondent said that it was a good way to view patients' information.

Specific aspect of the application least liked by the providers:

The DOT providers mentioned having technical problems, e.g. two or more centres getting a notification for the same patients, and suggested troubleshooting of this problem.

A 31-year-old female provider said,

> 'I and another centre received notification for the same patient. How [are] two branches of the same area receiving [a] notification for the same patients?'

Opinion on recommending this intervention to someone:

Most of the doctors interviewed (7/9) said that they never had the chance to recommend this application and relevant information to their friends or colleagues due to lack of time in their busy schedule or lack of interest among their peers. However, one senior doctor said he tried to convince one of his junior colleagues to use the Janao app, but his colleague did not wish to use it, as it is time-consuming. He said,

> 'I recommended this to one of my colleagues in a small gathering, right after the ward round, [and] he said it is problematic to use'.

The senior doctor also recommended holding orientation programs in various hospitals to sensitise the doctors and increase utilisation of the app.

Opinion on the orientation program:

The respondents said a single training session was not effective. In addition, two respondents said that refresher training should be held frequently to sensitise the doctors. One doctor said that the training was good but that the participants should be selected carefully, e.g. DOT providers and doctors should receive separate training. Another respondent said that the training should be held in the hospitals and communities so that all doctors who need the training can attend it at their designated workplace. A 44-year-old doctor said,

> 'A single training cannot be effective; that means new training and refresher training is a must to ensure the recipients' [learn] from training, and [the] result of their training could also be learnt in repeated sessions'.

One doctor requested an orientation for his assistants so that they could fill in the app when he was busy with his patients.

Perception of patient management using the application:

One doctor said that using the app did not make any changes in their patient management. The only change observed was that the patients could be located for follow-up after diagnosis. Another respondent said that the app is very advanced. A 46-year-old male doctor said,

> 'Earlier, we used to only refer patients to the TB centres. Now, after [the] diagnosis of patients, we can get information on their treatments along with registering (notifying) the patients'.

Discussion

In this study, which was conducted in Dhaka and enrolled patients with TB referred mostly from private providers, the median (Q1, Q3) delay in diagnosis was 45 (30, 70) days from symptom onset, and the delay in treatment initiation was 2 (2, 4) days after diagnosis. The total patient delay was 47 (29, 72) days. However, many other studies conducted in China, Indonesia, Iran, Iraq, Pakistan, Somalia, Syria, Yemen and India and two other systematic reviews and meta-analyses have shown the median diagnostic delay to be 23 to 91 days – or even as high as 366.5 days in one of the studies. These variations may be due to the country of study, the rural or urban residence of the patients, whether the patients have clinical symptoms, whether the patients are attending public or private hospitals, the duration or period of the study, the study settings, etc. (18-25). The mean treatment delay in the different studies was reported as being 1–8 days (19-21, 24). As we found here, most other studies reported a much longer diagnostic delay, whereas the treatment delay was generally short (19-21, 24). The median total delay in the different studies was 35 to 97 days from the onset of TB symptoms to the initiation of TB treatment; the mean total delay reported was 46 to 127 days (19, 20, 23, 24). Several of the studies reported delays such as patient delay (from symptom onset to first report) and health systems delay (from first symptom report to treatment initiation). The median patient delay was 9 to 53 days, whereas the median health system delay was 2 to 87 days in studies conducted in Bangladesh, Ethiopia, Iran, Iraq, Pakistan, Somalia, Syria and Yemen (23, 25, 26).

In our study, we considered multiple factors, e.g. age, duration of cough, other TB symptoms, diabetes status, education, marital status, rural/urban living area, wealth index of the patient's family, patient's knowledge of TB symptoms, type of facility the patient first visited and type of TB, which could lead to a patient delay of more than 30 days (12, 27, 28). Nearly, three-fourths (659, 73.6%) of the patients delayed seeking treatment after symptom onset. Though we found that most of the mentioned factors were statistically significant for patient delay, after adjusting for covariates, we found that having a cough >2 weeks, not having night sweats, being diabetic, being bacteriologically positive and trying self-treatment were statistically significant factors. However, many other studies conducted in China, Ethiopia, Indonesia, Iran, India, Pakistan and Bangladesh have shown that being male, older age, low socioeconomic level, lower education level, living in rural areas, being uninsured, not having clinical symptoms, being enrolled at a TB dispensary, initially visiting private providers, undertaking multiple visits prior to diagnosis, trying treatments other than anti-TB drugs, not using chest X-ray for TB diagnosis, trying self-treatment, having more than three family members, having smear-negative PTB, having extra-PTB, previous exposure to TB patients, stigma and visiting traditional healers/informal providers were significantly related to patient and health system delay (18-22, 24-26, 29, 30). Other studies done in Iran, Pakistan, India and

Bangladesh found that being ≥14 years old, being female, having a prison record, taking an Human Immunodeficiency Virus test, living in urban areas, having poor knowledge on TB and having bacteriologically confirmed TB were related to higher diagnostic and treatment delay (20, 21, 26, 30).

The findings of patient delay varied vastly across studies and countries, along with the relevant factors of the different types of delays. Our study findings represent the scenario from a public–private mix setup in the capital of Bangladesh, Dhaka. In these study sites, most of the patients were referred from private providers, so our findings relate closely to the population group seeking healthcare in these settings. Thus, addressing the significant factors found in this study should benefit the same group of people, if not others, in mitigating patient delay.

The qualitative assessment was conducted to document the patients' perception and understanding of the delay in diagnosis and treatment initiation. Lack of knowledge of TB, seeking healthcare from non-medical practitioners during symptom onset and reluctance to seek treatment from formal medical practitioners were found to be the key factors for the delay. Along with several other factors, the above findings are also reflected in another qualitative study conducted in Sudan (31). Moreover, we found that while 80% of the study participants had heard about TB, the majority did not know anything about the symptoms or transmission of the disease. This finding has been confirmed in similar studies (32, 33).

Our findings also indicated that it was common to seek initial treatment of cold, cough and fever from local pharmacies and informal medical practitioners. Due to their availability, easy access and low-cost treatment, patients preferred them as the first point of contact (34). Similar to other studies in the same territory (35, 36), we found that only when the patients' health condition worsened did they seek formal healthcare, which often aggravated the delay in TB diagnosis. Meanwhile, patients with undiagnosed TB might transmit the disease to close contacts (37).

Socioeconomic indicators also play a crucial role as determinants of patients' health-seeking behaviour and, thus, a significant determinant of patient delay. Similar to other global studies (37-39), we found that the study participants in our qualitative assessment belonged to the marginalised or disadvantaged group of their community and were from a low institutional background. However, in contrast, one study conducted in Brazil (40) showed that low income was not associated with patient or healthcare delay.

A significant number of participants did not collect their diagnostic reports on time. One-fourth of them delayed initiating TB treatment because of their negligence. Sometimes, due to location, they struggled to collect their TB medicines on time. It was also reported that a significant number of the participants did not rely on their medical practitioners and perceived that they were given the wrong treatment during their first treatment.

Another part of the study was focused on understanding the acceptability of the Janao app, which is intended for the mandatory patient notification of TB by private providers, in line with the gazette published by the GoB in 2014. Assessing the app's acceptability is crucial to understand the potential issues related to compliance, recruitment, retention and intervention delivery (41). The app's acceptability by both doctors and DOT providers was found to be mostly positive by our Likert scale findings. Most participants tended to choose the 'strongly agree' option for most of the responses. The same was found for all categories of the Likert scale responses, i.e. engagement with the application, ease of use of the application, usefulness of the application and difficulties with the application. The only response that most of the participants tended to respond to with the 'strongly disagree' option was 'There were some difficulties using the application' under the category 'Difficulties with the application category'. The continuation of brief training sessions could help maintain the users' compliance (42). Furthermore, the Janao app has the potential to notify a greater number of TB patients, as this seemed to be an acceptable option to the users after the initial training. The number of TB patients diagnosed by the doctors, was found four times higher than the number of patients they had notified through the app. This may be the result of the doctors' busy schedules and the newness of the app. The number of TB patients' information the DOT providers received through the app was found to be two times higher than the number of patients' enrolment information the DOT providers had entered into the app. This may have been due to lack of available digital devices for all personnel in the DOTS centres, changes of the duty locations of the DOT providers and the app being a new intervention.

The result of our qualitative assessment revealed that the doctors who participated in the study considered this app effective for TB treatment management. They also appraised this app as a helpful tool in terms of new patient notification and treatment enrolment. The DOT providers also found this app to be effective for referring and tracking patients with TB.

The doctors who participated in the qualitative assessment did not find any advantages of the Janao app in terms of diagnosing patients with TB. They also stated that this app required considerable time to operate and upload a patient's information and disease data. Other studies (43, 44) have concluded that new technology-mediated initiatives could be a helpful approach to improve TB treatment adherence. The app helps enrolment of patients with TB in the DOTS and thus facilitate treatment adherence in the long run.

Conclusion

Understanding the factors causing the delay between appearance of TB symptoms and treatment initiation is crucial to combatting the rising TB epidemic and helping policymakers design and implement TB control programs, as the treatment delay

affects not only individuals and their community but also the country's health and economy.

Accordingly, our analyses also found long delays before TB diagnosis and gaps between diagnosis and treatment initiation. To reduce the delay in diagnosis, measures such as awareness campaigns on TB could be arranged at regular intervals to sensitise the general population regarding TB symptoms, with a special focus on diabetic patients and those who self-treat, as we found that they are twice as likely to delay. Visits to informal providers should also be discouraged during these campaigns. Simultaneously, training on TB basics should be organised for informal providers so that they can refer patients with TB suggestive symptoms to doctors for further evaluation.

We also observed that the COVID-19 lockdown altered patients' health-seeking behaviour, further delaying their diagnosis and treatment, particularly post-lockdown. With the pandemic ongoing, programmatic intervention may be useful to raise awareness for TB and initiatives to maintain patient pathway for seeking care.

Despite suggesting some functional improvements to the Janao app, the study participants proposed sensitising more healthcare providers to utilise this app in regular practice. Continuing to communicate with and train doctors and DOT providers and engaging more doctors' assistants could help increase TB notification to reduce the number of missing TB cases (19% in 2019) significantly (3). This app could also be a bridge to link patients with diagnosed TB to DOT providers and, thus, reduce the delay in treatment initiation after diagnosis by doctors.

A limitation of this study was that it was not possible to include patients with TB, who did not come to collect their reports themselves, or were severely ill/hospitalised, a sub-population who might have learnt their diagnosis late or TB might have been an incidental medical finding for them. This challenge was aggravated during the COVID-19 situation. The number of participants enrolled during the pre-COVID phase (December 14, 2019–March 24, 2020) of this study was 642, while the remaining 253 participants were enrolled over the next five months. This massive decrease was not only due to patients' unwillingness to come and receive their reports because of social distancing recommendations and fear of co-infection but also due to the waning number of TB presumptive cases presenting at the icddr,b TBSTCs. Moreover, the onset of symptoms may not be precisely described by the patients, as the feeling of illness/suffering may vary from person to person or time to time. Recall bias might have occurred for patients who had been suffering long term. A limitation regarding the acceptability of the Janao app was that all responses, including those to the Likert scale, were based on the user's perception and understanding, which may also vary depending on the duration of their engagement with the app.

Recommendation

Policymakers could utilise the evidence generated from this study to bridge the gaps in the patient pathway by reducing diagnostic and treatment delays and connecting missing cases to the national reports via Janao, thus staying on track to reduce TB prevalence in the community and meet the goals of the SDG/End TB Strategies for TB prevention and control.

More specifically, awareness building in the community for TB will be fruitful. Many of the patients responding to our queries had lack of knowledge on TB disease, symptoms and where to seek care. So, these issues should be included while planning for community awareness on TB. Ensuring more access to TB care services will also help. Connecting informal providers with national TB control program can also result into better TB case detection. Many of the respondents visited informal providers at the beginning of their illness, adding to delay in ultimate diagnosis and treatment of TB. So, they should be linked in the pathway to diagnosing TB by ensuring that they learn properly on TB symptoms and referral linkage by organized trainings. In addition, active case finding can help in reducing delays made by the patients due to all the different factors.

For scaling up Janao, engagement of the PPs & DOT providers should be continued and reinforced. Most of the physicians and DOT providers expressed their interest on the app and recommended that these should be used by larger group of users. Further scale up plan should be done to include additional users and geographic areas. Many had opined that in addition to the training and orientation during registration with the app, refresher training afterwards on usage of the app will help in maintaining adherence to the mechanism. So, plans to incorporate provision of such training/orientation should be considered for all the users. Ensuring consistent availability of digital devices and internet for the DOT providers is essential. Many of them shared that often lack of digital devices or internet hampers their role through Janao - resolution of this issue should be prioritized.

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