Estimation of subnational tuberculosis burden
Finding gaps in routine surveillance activities in Bangladesh by linking prevalence survey and case notification data

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Introduction
Where are the missed Tuberculosis (TB) cases?

WHO’s End TB strategy and SDG 3.3
- Reducing TB deaths by 95% and new cases by 90% between 2015 and 2035
- Globally, 41% people who develop TB every year missing from care; greatest challenge in high-burden countries

Bangladesh is a high-burden country for TB
- Estimated 361K incident cases and 38K deaths in 2019
- Two national prevalence surveys: 2007-09, and 2015-16

Prior spatial investigations of TB in Bangladesh
- KIT Royal Institute and NTP found large sub-national variations in TB case notification rates (CNR)
- Areas with low CNR suggest potential for missed cases
Study aims
Producing metrics to identify people living with TB missed by the health system

Knowledge gap
CNR are a product of TB program effectiveness and underlying TB burden. Assessing sub-national disparities in routine surveillance activities requires estimates of local TB burden.

Specific Aims
1. Present methods to analyze national TB prevalence survey sub-nationally
2. Provide actionable estimates of the TB epidemics in Bangladesh at a policy-relevant unit of analysis
3. Identify areas with the largest number of TB cases missing from care
Data

Prevalence survey data
- 2015-16 National prevalence survey
  - Considered 2009-11 prevalence survey
- 98,710 individuals across 125 sampled clusters
- 278 bacteriological confirmed cases

Case notifications
- Data collected from NTP 2012-2016
- Reported for each 64 districts (by age/sex groups)

Population & socio-demographic/environmental data
- Population data by district from Bangladesh 2011 census
  - Used to calculate counts from rates
- Socio-demographic/environmental covariates considered
Statistical analysis

Estimating TB prevalence rates
- Districts with no or one cluster
- Undefined/untrustworthy estimates
- Area-level model → precision

\[
\begin{align*}
\text{logit}(p_{HT}^i) & \sim N(\theta_i, V_i) \\
\theta_i & = X_i^T \beta + \epsilon_i + S_i
\end{align*}
\] (1a) (1b)

where \(\epsilon_i \sim N(0, \sigma^2_\epsilon)\), \(S_i = 1, \ldots, n \sim \text{ICAR}\)

Prevalence-to-notification ratio
\[P : N_i = \frac{\hat{p}_i}{\text{CNR}_i}, \hat{p}_i = \exp(\hat{\theta}_i)\]
from (1b)

Counterfactual analysis
How many more cases notified if district did at least as well as national prevalence-to-notification ratio? (\(P : N_0 = 2.8\))

\[N_i^* = \frac{\hat{p}_i}{\min(P : N_i, 2.8)} \Rightarrow N_i^* - N_i \]
"Missed cases" (notifications)

Figure – Observed prevalence at clusters
Outline

1. Background
2. Methodology
3. Results
4. Discussion
5. Appendix
TB prevalence rates by districts

Figure – Estimated TB mean prevalence (per 100,000) (a), and 97.5th (b) and 2.5th (c) percentiles
Figure – Estimated mean number of people living with TB (a), and 97.5th (b) and 2.5th (c) percentiles
TB prevalence-to-notification ratio by districts

Figure – Estimated mean TB prevalence-to-notification ratio (a), and 97.5th (b) and 2.5th (c) percentiles
"Missed TB cases" (notifications) by districts

Figure – Estimated mean additional cases that could be notified (a), and 97.5th (b) and 2.5th (c) percentiles
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Main findings

Clear spatial patterns

1. High prevalence rates in the northern, north-eastern districts
2. Highest number of prevalence cases in same districts, along with most populated areas, including Dhaka and Chattogram
3. Largest prevalence-to-notification ratio in north-eastern districts, and most districts of Rajshahi and Dhaka divisions
   - Moderate prevalence rates, but strikingly low CNR
   - Interesting similarities with NTP/KIT study of CNR

Counterfactual analysis

- ≈ 26,500 additional cases detected if sub-national inequities in prevalence-to-notification ratio resolved
- ≈ 16,000 in just 4 districts
Limitations

**Limited, older TB prevalence data**

- Study focused on active TB, not latent TB infections; and did not distinguish between drug-susceptible, MDR and XDR TB
- Could not use 2007-09 survey; prevented us from estimating temporal trends
- Data from 2016; COVID may have disrupted TB services and changed geographic patterns presented here

**Limited data about risk factors**

- Absence of sub-national prevalence data for known TB risk factors (smoking, alcohol, diabetes)
- Estimated prevalence of over-crowding and use data about poverty, but limited use
Comparison with Kit study

Figure – Estimated mean prevalence-to-notification ratio

Figure – Rood et al., 2018, Figure 4