

Estimation of burden of tuberculosis in India for the year 2000

P.G. Gopi, R. Subramani, T. Santha, V. Chandrasekaran, C. Kolappan, N. Selvakumar & P.R. Narayanan

Tuberculosis Research Centre (ICMR), Chennai, India

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Background & objectives: Data on the burden of tuberculosis (TB) in India are vital for programme planners to plan the resource requirements and for monitoring the nation-wide TB control programme. There was a need to revise the earlier estimate on the burden of TB in India based on the increase in population and current epidemiological data. This study estimates the burden of disease for the year 2000 based on recent prevalence of TB and annual risk of tuberculosis infection (ARTI) estimates.

Methods: Data on prevalence generated among adults by the Tuberculosis Research Centre (TRC), Chennai, among children by National Tuberculosis Institute (NTI), Bangalore, and the ARTI estimates from the nation-wide sample survey by NTI and TRC were used for the estimation. The prevalence of disease corresponding to 1 per cent ARTI was extrapolated to different parts of the country using the estimates of ARTI and the population in those areas and added together to get the total cases. Abacillary cases that required treatment were estimated from X-ray abnormalities. The estimates of bacillary, abacillary and extrapulmonary cases were then combined to get the national burden.

Results: The estimated number of bacillary cases was 3.8 million (95% CI: 2.8 - 4.7). The number of abacillary cases was estimated to be 3.9 million and that for extrapulmonary cases was 0.8 million giving a total burden of 8.5 million (95% CI: 6.3-10.4) for 2000.

Interpretation & conclusion: The present estimate differs from the earlier estimates because we have included the disease burden of X-ray cases that are likely to breakdown to bacillary cases in a one year period, and extrapulmonary TB cases. The current estimates provided baseline information for advocacy and planning resource allocation for TB control activities. Also, these estimates can be compared with that in future years to measure the long term impact of TB control activities in India.

Key words Abacillary - bacillary - extrapulmonary TB - India - TB burden

India, with its population of over 1000 million, is estimated to account for nearly 30 per cent of the global tuberculosis burden¹. Tuberculosis (TB) continues to be a major health problem in India

because of its high mortality and morbidity². Data on the burden of tuberculosis are vital for programme planners in order to calculate the resource requirements, and monitor the nation-wide TB control

programme. The National Tuberculosis Control Programme (NTP) was implemented in 1962. However, when reviewed in 1992, after three decades of implementation, the NTP was shown to have made no epidemiological impact, mainly due to poor case finding and low treatment completion rates³. As a result, the Government of India (GoI) in 1993 developed the Revised National Tuberculosis Control Programme (RNTCP) based on the internationally recommended Directly Observed Treatment – Short course (DOTS) strategy. Since 1998, the RNTCP has undergone a rapid expansion, and by November 2004 covered a population of over 920 million⁴. Based on the findings of the National Sample Survey (NSS) conducted by Indian Council of Medical Research (ICMR) during 1955-58⁵, an estimate of the burden of TB in India of 3.5 million bacillary cases and 14 million persons with abnormal chest X-rays suggestive of tuberculosis with negative sputum (hereafter, referred to as X-ray abnormalities) was made at the time of introduction of RNTCP in 1997⁶. In 2000, an expert committee convened by the GoI, analyzed the data available from comparable studies, and estimated the burden in the year as 4.32 million bacillary cases and 11 million X-ray abnormalities (unpublished data). The estimated X-ray abnormalities reported could be an overestimate because the non-specific shadows in the X-rays could be due to various other diseases and would also include patients who would never develop TB. Also, extrapulmonary cases were not included in these estimates. The population of India has increased substantially after these estimates were obtained. Considering the above points, it was thought necessary to revise this estimate using the current epidemiological data available. Further, there is a need to estimate, as accurately as possible, the burden of TB at the start of the RNTCP in order to assess the impact of the programme as it is implemented and for the logistic purposes. The present study was undertaken to estimate the current disease burden in India for the year 2000 based on recent prevalence of disease and annual risk of tuberculosis infection (ARTI) estimates⁷⁻⁹.

Material & Methods

This report summarizes the estimation of burden of disease based on recent prevalence and ARTI estimates generated by Tuberculosis Research Centre

(TRC), Chennai, disease survey among children by National Tuberculosis Institute (NTI), Bangalore and the ARTI estimates from the nation-wide sample survey by NTI and TRC⁷⁻⁹. For the estimation of the burden of tuberculosis, the following definitions were used.

Bacillary case: (i) Sputum-smear-positive case: A person with at least one sputum smear positive for acid fast bacilli (AFB) by fluorescent microscopy, irrespective of culture results; (ii) Sputum-smear-negative, culture-positive case: A person with sputum smears negative on all specimens collected for AFB, but at least one culture positive for *Mycobacterium tuberculosis*.

X-ray abnormalities: Chest X-ray was read as possible or probable tuberculosis by two independent readers with sputum negative by smear and culture.

Abacillary case: Of the X-ray abnormalities, those who are likely to break down to bacillary cases or radiological progression warranting initiation of anti-TB treatment.

Extrapulmonary tuberculosis: Tuberculosis affecting other than lung parenchyma.

The data used for the estimation of the burden of disease, were obtained from three different sources - (i) During 1999-2001, TRC undertook a large scale community survey in a sub-district population of Tiruvallur district in south India, to estimate the prevalence of TB disease among the population aged ≥ 15 yr, and an ARTI survey⁸. In the disease prevalence survey, two screening tools namely, symptom elicitation and chest radiography, were used for the detection of cases. The adjusted prevalences of smear-positive, smear-negative culture-positive and X-ray abnormal cases were estimated. The ARTI was estimated by the mirror image method¹⁰; (ii) Data on the disease prevalence among children aged 0-14 yr from a survey⁹ conducted by the NTI which was correlated with the south zone ARTI of 1 per cent (95% CI: 0.7-1.4%)⁷; and (iii) The ARTI estimates from rural and urban areas obtained from the nation-wide survey, conducted jointly by NTI and TRC⁷ during 2000-2003.

Data analysis: The burden of disease was estimated as follows: the prevalence of disease corresponding to 1 per cent ARTI in the Tiruvallur study was

multiplied by the corresponding ARTI estimates from the nation-wide ARTI survey for the rural and urban areas of the four survey zones to get the estimates of the prevalence in the respective areas. These estimates of prevalence were then multiplied by the adult population in the respective areas, to obtain the estimated number of prevalent cases. The prevalence among children was estimated in the same way assuming for an ARTI of 1 per cent as obtained from the south zone⁵. The number of abacillary cases was estimated assuming a breakdown of 30 per cent of X-ray abnormalities that required treatment¹¹ and extrapulmonary cases as 20 per cent of bacillary cases. These estimates of bacillary, abacillary and extrapulmonary cases were then combined to get the national burden.

The rates of prevalence of smear-positive cases, smear-negative culture-positive cases, and X-ray abnormalities were estimated after adjusting for those not examined by X-ray and/or sputum examinations. The 95 per cent confidence intervals (CI) were obtained for the burden estimates. The prevalence based on the screening methods namely, symptom and radiography screening among adults for smear-positive cases, and smear-negative culture-positives were 333 and 332 per 100,000, respectively. The corresponding figures for prevalence based on radiography alone were 282 and 266, respectively. The prevalence rate of X-ray abnormalities among adults was 2360 per 100,000. For children, the corresponding figures were 26, 123 and 300 per 100,000, respectively. The ARTI was estimated to be 2.0 per cent (95% CI: 1.7-2.3) by the mirror-image technique for the age group of 1-9 yr.

Extrapolation of data: Based on the census of India-1991 and 2001, the population of India for 2000 was taken to be 1005 million with 35 per cent of the total population aged 0-14 yr. As there are no data available on the prevalence of disease at the national level, prevalence data among adults generated by the TRC survey and that among children by NTI, were extrapolated for the national estimation.

Results & Discussion

The estimated number of bacillary cases was 3.75 million (95% CI: 2.8-4.7), of which 1.7 million (95% CI: 1.3-2.1) were smear-positive cases and 2.05 million (95% CI: 1.5-2.6) smear-negative, culture-positive

cases (Table I). X-ray abnormalities were estimated to be 12.9 million (95% CI: 9.7-16.0). The number of abacillary cases was estimated to be 3.9 million (30% of 12.9 million X-ray abnormalities) with 95 per cent CI: 2.9 - 4.8 and that for extra-pulmonary cases was 0.8 million (20% of 3.8 million bacillary cases) with 95 per cent CI: 0.6-0.9 giving a total burden of 8.5 million with 95 per cent CI: 6.3-10.4 (Table II).

To get a direct estimate of burden of TB disease in India, a large scale national survey would be required. However, due to lack of recent data on the nation-wide prevalence of disease, the estimated burden of tuberculosis presented here was based mainly on data generated from an area where community disease and ARTI surveys are in progress, and on estimates of ARTI in different parts of the country from the recent nation-wide ARTI survey⁷. There are inherent limitations in undertaking such an exercise using the available data. However, despite the limitations, we estimated that in the year 2000 there were 3.8 million bacillary cases and 12.9 million X-ray abnormalities. All the X-ray abnormalities estimated here may not be bacillary cases and most of them may not develop to active cases in future. The question whether it would be correct to treat these sputum-negative X-ray abnormalities assumes national importance from burden estimation point of view. A study¹¹ conducted by NTI in 1975-76 followed up X-ray abnormalities for one year and found that about 30 per cent broke down either with bacillary disease or radiological progression. Another study¹² in Hong Kong showed that confirmation of active disease requiring treatment was obtained for 76 (42%) of the 181 X-ray abnormalities during a 12 month period. About 30 per cent of the X-ray abnormalities had chest symptoms in addition in the TRC series (unpublished data). Considering all these factors, it was reasonable to assume that 30 per cent of the X-ray abnormalities at the time of the survey to be active cases of TB. Thus, 30 per cent of 12.9 million X-ray abnormalities, were likely to break down to bacillary cases or progress radiologically requiring anti-TB treatment; 3.9 million (12.9 x 30%) of the X-ray abnormalities were alone considered to be abacillary cases. The number of extrapulmonary cases was estimated to be 0.8 million of 3.8 million bacillary cases (20% of 3.8). Thus, the burden of tuberculosis projected in the country for the year 2000 was 8.5 million.

Table I. Zone-wise urban and rural populations and number of cases (in million)

Zone	ARTI %	Population	Smear-positive	Smear-negative, culture-positive	Total bacillary cases	X-ray abnormalities
East - Rural	1.2	213.3	0.294	0.355	0.649	2.232
Urban	1.6	46.0	0.085	0.102	0.187	0.642
North - Rural	1.5	177.9	0.306	0.370	0.676	2.327
Urban	3.3	58.2	0.221	0.266	0.487	1.675
South - Rural	0.8	164.1	0.151	0.182	0.333	1.145
Urban	1.6	70.2	0.129	0.156	0.285	0.979
West - Rural	1.4	191.4	0.308	0.372	0.680	2.336
Urban	2.1	84.0	0.203	0.245	0.448	1.539
Total (95% CI)	1.5	1005.1	1.70 (1.28-2.11)	2.05 (1.54-2.55)	3.75 (2.82-4.66)	12.87 (9.72-16.03)

ARTI, Annual risk of tuberculosis infection

Table II. Estimated burden of tuberculosis in India for the year 2000 (in million)

Type of case	No. (95% CI)
Bacillary cases	3.8 (2.8-4.7)
Abacillary cases	3.9 (2.9-4.8)
Extrapulmonary cases	0.8 (0.6-0.9)
Total cases	8.5 (6.3-10.4)

In 1997, Dye *et al*¹ estimated the incidence of TB in India to be 1.8 million (187 per 100,000 population) and arrived at the prevalence of TB (505 per 100,000) by multiplying the incidence by the duration (2.7 yr) of the disease. On similar lines, the estimated incidence for the year 2000 was 180 per 100,000 population¹³. These estimates were obtained by reviewing data from notification of TB cases without including X-ray abnormalities and extrapulmonary cases. From the 1955-58 NSS, based on radiography alone as the screening tool, the prevalence of bacteriologically positive cases was 400 per 100,000 population and that for X-ray abnormalities 1600 per 100,000 population. In 2000, an expert committee convened at NTI, Bangalore by the GoI, analyzed the data available at that time from comparable studies, and estimated the burden in the year 2000 as 4.32 million bacillary cases and 11 million X-ray abnormalities (unpublished data). The present estimation is based on prevalence data generated from using both symptom elicitation and chest radiography for the diagnosis of tuberculosis cases and hence the estimate is likely to be more accurate. The current

burden using chest radiography alone as the screening method, and using the same methodology as in the NSS, was estimated to be 320 bacillary cases per 100,000 population. The current estimates have taken into account the population increase in the country and the recent available prevalence data. As RNTCP is showing remarkable success in terms of cure rate and nation-wide coverage is planned for 2005, it is expected that the burden of prevalent cases should decrease considerably over a period of few years. The current burden of TB in the country can be compared with the burden in few years time, the long term impact of the programme could be measured.

Our estimation has the following limitations: We have assumed that the relationship between the ARTI and the prevalence of disease was similar in all four zones of the country and that TB control measures and outcomes were similar across the country. The latter assumption was probably reasonable because only 180 million population were covered under the DOTS-based RNTCP in January 2000. The age-sex composition of the adults in the study population of Tiruvallur was found to be similar to the general population of India. So the burden of estimate is unlikely to differ significantly from the present estimate. On the whole we have not attempted to estimate the burden of disease adjusting for age and sex. The impact of HIV on the epidemic was not considered separately. To the extent that HIV contributes to transmission, may be partly accounted for by the impact on the ARTI. There is evidence

from Africa that the impact of HIV infection on incidence is much greater than on prevalence¹⁴, thus the methodology used here would lead to an underestimate of TB incidence. However, the overall prevalence of HIV in Tiruvallur is still less than 1 per cent (unpublished data) so, the effect is unlikely to be substantial. Since the current estimate of the incidence rate was not available and we could not establish the relationship between ARTI and incidence of smear-positive cases, we used the relationship between ARTI and prevalence rates. Hence, the possible errors in comparison of ARTI with the prevalence of the disease have also not been considered.

The present study provides a point-estimate for the year 2000 and the impact of growing population with passage of time is therefore not appropriate here. This study is an exercise aimed at providing a rough estimate for the programme manager. A mathematical modeling might be needed to provide a range of different estimates based realistic assumptions and allowing impact of growing populations.

In conclusion, the burden of TB for the year 2000 was estimated to be 8.5 million (3.8 million bacillary cases, 3.9 million abacillary cases and 0.8 million extrapulmonary cases). These estimates provided baseline information for advocacy, planning resource allocation and to measure the impact of TB control activities in India in future.

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Reprint requests: Dr P.R. Narayanan, Director, Tuberculosis Research Centre, Mayor V.R. Ramanathan Road
Chetput, Chennai 600031, India
e-mail: nrparanj@md2.vsnl.net.in