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TUBERCULOSIS AND DISABILITY-ADJUSTED LIFE YEARS (DALYs) LOST IN MUMBAI

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Abstract

DALY is an indicator of BOD (Burden of disease) in a population. It takes into account not only premature mortality, but also disability caused by disease or injury. As a new single summary measure was introduced in a 1990 Global Burden of Disease Study (GBDS) that represented a major step in quantifying global and regional effects of diseases, injuries, and risk factors on population health. The objectives of the study are to understand the pattern of TB morbidity and mortality in Mumbai, to measure the burden of tuberculosis by using the indicator of DALY. This study is based on secondary data from Mumbai District TB Control Society (MDTCS), office of City TB Officer, data of TB mortality from March 2012 to March 2013. The limitation of the study is that this study is limited to Mumbai metropolitan only. The limitation of the study is that this study is limited to Mumbai metropolitan only. The result of the study showing, the mortality pattern of tuberculosis in Mumbai shows that in year 2012-2013, there is total 214 deaths caused due to the TB, among these deaths, six deaths occurring in 0-14 years age group, in this age group there is 4 male and 2 female child, maximum number of deaths occurring in 15-65 years age group, in this age group total 169 (78.97%) deaths caused due to tuberculosis and among that 112 (52.33%) are male and 57 (26.33%) are females.

Key words: *TB, DALY, Mortality...*

Introduction

Health in the broad sense of the world does not merely mean the absence of disease or provision of diagnostic, curative and preventive services. It also includes as embodied in the WHO definition, a state of physical, mental and social well-being. The harmonious balance of this state of the individuals into his environment constitutes health, as defined by WHO (Park, 2005). Health care is an expression of concern for fellow human beings. It is defined as a "multitude of services rendered to individuals" families or communities by the agents of the health services or professions, for the purpose of promoting, maintaining; monitoring or restoring health (Park, 2005).

Tuberculosis is one of the most dreaded health problems in India. It is also one of the targets of the Millennium Development Goals (MDGs).Tuberculosis is an infectious disease caused by Mycobacterium tuberculosis. The disease primarily affects lungs and causes pulmonary tuberculosis. It can also affect intestine, meninges, bones and joints, lymph glands, skin and other tissues of the body. The disease is usually chronic with varying clinical manifestations. The disease also affects animals like cattle; this is known as "bovine tuberculosis", which may sometimes be communicated to man (Park, 2005).

There are four steps in diagnosing TB disease: medical history, tuberculin skin test, chest x-ray, and bacteriologic examination. Tuberculosis remains a world-wide public health problem despite the fact that the causative organism was discovered more than 100 years ago and highly effective drugs and vaccines are available making tuberculosis a preventable and curative disease (Park, 2005).

Burden of Disease

As per the WHO Global TB Report 2011, there were an estimated 8.8 million incidences of TB (range, 8.5 million-9.2 million) globally in 2010, 1.1 million deaths (range, 0.9 million-1.2 million) among HIV-negative cases of TB and an additional 0.35 million deaths (range, 0.32 million-0.39 million) among people who were HIV positive. In 2009, there were an estimated 9.7 million (range, 8.5-11 million) children who were orphans as a result of parental deaths caused by Tuberculosis. Globally, the absolute number of incident TB cases per year has been falling since 2006 and the incidence rate (per 100 000 population) has been falling by 1.3% per year since 2002. If these trends are sustained, the MDG target that TB incidence should be falling by 2015 will be achieved. Estimates of TB mortality have substantially improved in the past three years, following increased availability and use of direct measurements from vital registration systems and mortality surveys. In this report, direct measurements of mortality are used for 91 countries (including China and India for the first time).

India has the highest tuberculosis burden accounting for one fifth (21 Percent) of the global incidence. The global annual incidence estimate is 9.4 million cases out of which it is estimated that 2 million cases are from About 4.17 lakh people die of tuberculosis every year, two persons die every three minute, and about 1000 people die every day. Since 1993, India has successfully implemented Revised National Tuberculosis Control Programme (RNTCP) using DOTS strategy. RNTCP has incorporated all elements of Stop TB strategy and already covered the

entire country since March 2006. Since its inception, the programme has initiated more than 12.8 million patients on treatment, thus saving nearly 2.3 million additional lives (http://tbcindia.nic.in). The 4.4 percent death rate in RNTCP areas is substantially lower than the 29 percent mortality documented among treated smear positive tuberculosis patients in non-RNTCP areas (Park, 2005).

The burden of suffering caused by tuberculosis in India is enormous. It is one of the biggest public health problems in India. Indian worker with tuberculosis loose on an average lost about 83 work days because of the disease, 48 of which are lost while shopping for diagnosis. Considering the 2 million new cases reported annually in India, the national loss per year works out to 166 million lost work days at a cost of about $ 200 million. Tuberculosis kills more women in reproductive age group than all causes of maternal mortality combined, and it may create more orphans than any other infectious disease. Drug resistance surveillance in several areas in India has found that 3.4 per cent of new patients have multidrug resistant tuberculosis. This is higher than many countries but much lower than in hot spot described by WHO.

Indian TB case notification statistics

In 2012 India declared TB to be a modifiable disease, meaning that with immediate effect all private doctors, caregivers and clinics treating a TB patient had to report every case of TB to the government (TB facts, 2013).

TB case notification statistics for India

Year	Population of India covered under RNTCP	Total TB cases notified	Total smear positive TB cases notified	New smear positive TB cases notified	New smear negative TB cases notified	New extra pulmonary TB cases notified	Retreatment cases notified
2005	1,04,20,00,000	12,94,550	6,76,542	5,07,089	3,92,679	1,70,783	2,24,630
2006	1,11,20,00,000	14,00,340	7,46,149	5,54,914	4,01,384	1,83,719	2,60,618
2007	1,12,80,00,000	14,74,605	7,90,463	5,92,262	3,98,707	2,06,701	2,76,936
2008	1,14,80,00,000	15,17,363	8,15,254	6,16,027	3,90,260	2,20,185	2,89,222
2009	1,16,40,00,000	15,33,309	8,25,397	6,24,617	3,84,113	2,33,026	2,89,756
2010	1,17,70,00,000	15,22,147	8,31,429	6,30,165	3,66,381	2,31,121	2,92,972
2011	1,21,00,00,000	15,15,872	8,44,920	6,42,321	3,40,203	2,26,965	3,04,431

Source: TB facts, 2013

Annual risk of tuberculosis infection (ARTI) study conducted in 2000-2003. The national ARTI being 1.5%, the incidence of new smear positive TB cases in the country is estimated as 75 new smear positive cases per 100,000 populations. The prevalence of TB has been estimated at 3.8 million bacillary cases for the year 2000, by an expert group of Govt. of India. However the recent estimate by WHO gives a prevalence of 3 million. On a national scale, the high burden of TB in India is illustrated by the estimate that TB accounts for 17.6% of deaths from communicable disease and for 3.5% of all causes of mortality (WHO, 2004). More than 80% of the burden of tuberculosis is due to premature death, as measured in terms of disability-adjusted life years (DALYs) lost (TB India report, 2012,). As the topic of this study the concept of DALY is given in the further topic in this paper.

Disability-Adjusted Life Year (DALY) concept

DALY is an indicator of BOD (Burden of disease) in a population. It takes into account not only premature mortality, but also disability caused by disease or injury. As a new single summary measure was introduced in a 1990 Global Burden of Disease Study (GBDS) that represented a major step in quantifying global and regional effects of diseases, injuries, and risk factors on population health. It is worth to note that DALYs are an inverse form of the more general concept of QALYs (Man of group, 2013).

DALY = YLL + YLD

YLL: The in the GBD study are calculated by multiplying the number of death cases (N) at a certain age of death with the remaining life (L) expectancy at age of death (x) as taken from the standard life table:

$$YLL = N * Lx$$

It is also essential to define the health goal that can be used as a reference value to calculate the difference between the ideally expected and the truly observed values and patterns.

The Potential Years of Life Lost (PYLL) are used by the Organization for Economic Co-operation and Development (OECD) as an indicator for the mortality related disease burden.

YLD: As the main idea of DALY measure was to describe the impact of disabling primary non-fatal diseases on population health. To calculate the years of life lost due to disability for a particular disease, it is needed to have information on the number of incident cases and the

duration of the disease/injury as well as information on the severity of the disease/injury is needed. The YLDs are calculated using the following simplified formula:

$$YLD = I*DW*D$$

Where, I describe the number of incident cases, DW the disability weight (on a scale from 0 to 1) and D the duration of the disabling state.

Two dimensions of DALYs

The DALY is a time-based measure that combines years of life lost due to premature mortality and years of life lost due to time lived in health states less than ideal health. One DALY can be thought of as one lost year of "healthy" life, and the BOD can be thought of as a measurement of the gap between current health status and an ideal situation where everyone lives into old age, free of disease and disability. In other words, DALYs are the combination (more precisely the sum) of two dimensions: the present value of future years of lifetime lost through premature mortality, and the present value of years of future lifetime adjusted for the average severity (frequency and intensity) of any mental or physical disability caused by a disease or injury (Man of group, 2013).

The years of life lost dimension

As a basis for the DALY measure, a "gold standard", or most desirable life, is defined as living in a completely healthy state until death at age around 80 years. The "ideal" life is quantified as the total area in the box, a combination of the number of years lived and the full quality of life without disability. For each premature death1, the number of years lost is counted up to the "standardised" maximum life span. The standardised maximum life span is 82.5 years for females and 80 years for males. It is taken from the country with the highest life expectancy in the world, Japan. Such a measure of premature death in number of years lost is known as "years of life lost"(YLL). This approach increased the validity of comparisons of the burden of different diseases between world regions and countries over time. In fact, the World Bank and the World Health Organisation (WHO) were the first institutions to use the DALY measures to compare the BOD in different regions of the world and thereby the value and effectiveness of different health interventions and changes in living conditions. It became possible to estimate and compare the cost of avoiding the loss of a DALY for each intervention.

Literature review

In the study, entitled "A cost-benefit analysis of scaling up tuberculosis control in India" by M. Good child, S. S., based on the scale-up period from 1997 to 2006,to measure the health benefits of DOTS (directly observed treatment short course) they used the term of the disability-adjusted life years (DALYs) gained from DOTS relative to the counterfactual situation. A disability weight of 0.271 was used in the study, based on the average weight for TB morbidity across South-East Asia. A 3% discount rate was also adopted, but no subsequent 'age weights' were applied.

The result of the study shows that the scale-up of TB control in India has resulted in a total health benefit of 29.2 million disability adjusted life years (DALYs), including 1.3 million deaths averted. In 2006, the burden of TB measured in terms of DALYs lost would have been 1.8 times higher in the absence of the programme. The total gain in economic well-being from TB control is estimated at US$88.1 billion over the 1997–2006 10-year periods. Total public expenditure on TB control over this period amounted to US$768 million, with the RNTCP accounting for US$299 million and other health sector costs accounting for US$469 million. The cost of TB control averaged just US$26 per DALY gained over 1997–2006 and generated a return of US$115 per dollar spent.

In conclusion, the study states that the scale-up of TB control under the RNTCP have proven a very cost-effective mechanism to improve the health status of India's population, while the return on investment has been exceptional from a societal perspective. India has also made considerable progress towards the MDG and Stop TB Partnership targets nationally as a consequence. However, the programme continues to face many challenges that will need to be addressed to ensure that further progress is made towards the control of TB in India.

A study conducted at TB research centre, Chennai among New Sputum Positive (NSP) cases found that the total costs, and particularly indirect costs due to TB for entire 6 months of treatment were high. The direct cost of TB to Indian society is about $300 million and indirect cost is about $3 billion. The study also found that the average period of loss of wages was 3 months. In Indian society, productive work days lost due to TB illness are 100 million and productive work days lost due to TB deaths are 1.3 billion. The impact on school going children was that about one fifth school going children discontinued their education because of being affected by TB or because their parents were unable to send children to school because of their

poor health and economical condition. In India, 300000 school going children were found to be dropping out due to parental TB. The impacts on women were that many of them suffering with Tuberculosis were rejected by their families due to TB (Rajeshwari, 2009).

The study titled "Cost effectiveness analysis of strategies for tuberculosis control in developing countries like Africa and South East Asia" in context to understanding the achievements on the millennium developments goal for health. Showed that treatment of new cases of smear-positive tuberculosis in DOTS programmes cost $ internationally 6-8 per DALY averted in Africa with high child and very high adult mortality (Afr-E countries) and $ Internationally 7 per DALY averted in South-East Asia with high child and high adult mortality (Sear-D countries) at coverage levels of 50-95%. In Afr-E, adding treatment of smear-negative and extra-pulmonary cases at a coverage level of 95% cost $Internationally 95 per DALY averted; the addition of DOTS-Plus treatment for multidrug resistant cases cost $Int123. In Sear-D, these costs were $Int52 and $Int226, respectively. The full combination of Interventions could reduce prevalence and mortality by over 50% in Sear-D between 1990 and 2010, and by almost 50% between 2000 and 2010 in Afr-E. It was concluded that to achieve the millennium development goal for tuberculosis control, substantial extra investment was needed to increase case finding and implement interventions on a wider scale (Rob Baltussen, 2005).

Despite the availability of highly efficacious treatment for decades, tuberculosis remains a major global health problem. In 2010, there were an estimated 8.5–9.2 million cases and 1.2–1.5 million deaths (including deaths from tuberculosis among HIV positive people). Tuberculosis continues to remain a major burden in developing countries, including India. The WHO estimated that globally the largest burden of tuberculosis deaths in 2010 occurred in the South-East Asia Region, which accounted for 40% of incident cases (3.5 million) and 45% of deaths (0.5 million). However, the estimated incidence rate per 100,000 persons in sub-Saharan Africa was ~50% higher than that of the South-East Asia Region (276 vs. 193). India ranks first in terms of both number of incident cases (2.3 million) and deaths (0.32 million); accounted for an estimated one quarter of the total burden, globally. The effect of HIV on tuberculosis in sub-Saharan Africa accounted for the massive increase in the incidence of tuberculosis in the last 20 years; however, not much is being reported from India. (Mangesh s. Pednekar, 2012).

Rational of the study

Tuberculosis is a major public health problem for India being second only to Malaria. The vast majority of tuberculosis deaths are in the developing world. Left untreated, each person with active tuberculosis disease will infect on average between 10 and 15 people every year and this continues the tuberculosis transmission. Preventing TB deaths brings no savings in the costs of TB control unless it is accompanied by a reduction in incidence so that fewer patients require treatment. The prompt and effective treatment of active disease is almost certainly reducing transmission around the world, but because the effect on incidence is necessarily slow, it has been hard to quantify in all but a few countries, (Suarez and others 2001).

The burden of TB is somewhat greater in Mumbai, as it is the centre for secondary and tertiary health care services for a large part of western India as well as for the migrants. The presence of specialised hospitals worsen disease burden and inflate the figures. This study is an attempt to find out disease burden at local level so the data generated may contribute to planning and programming at district or local level and may help better allocation of resources.

Objectives of this study

- To understand the pattern of TB morbidity and mortality in Mumbai.
- To measure the burden of tuberculosis by using DALY as an indicator.

Data and Methods

This study is based on secondary data from many sources as there is no single comprehensive data source which provides all thee required information on age specific deaths due to tuberculosis. Hence the researcher used the secondary sources to fulfil objectives of the study:

1. Mumbai District TB Control Society (MDTCS), office of City TB Officer, data from March 2012 to March 2013.

Calculation of DALYs

DALY = YLL + YLD

The study used the method of Disability-adjusted life years (DALY) to understand the DALY lost in Mumbai. Calculation of DALYs with discounting- when 3 percent discounting and age weights are considered, the formulas for calculating YLLs and YLDs.

$$YLL= \{KCe^{ra}/(r+\beta)\}^{2*}\{e^{-(r+\beta)(L+a)}[-(r+\beta)(L+a)-1]-e^{-(r+\beta)a}[-(r+\beta)a-1]\}+(1-K)/r(1-e^{-rl})$$

YLL = years of life lost due to premature death

K = age-weighting modulation constant (K=1)

C = adjustment constant for age weights (GBDS standard value is 0.1658)

r = discount rate (GBDS standard value is 0.03)

a = age of death (years)

β = age-weighting constant (GBDS standard value is 0.04)

L = standard life expectancy at age of death (years)

$$YLD = DW*[\{KCe^{ra}/(r+\beta)\}^{2*}\{e^{-(r+\beta)(L+a)*}[-(r+\beta)(L+a)-1] - e^{-(r+\beta)a*}[-(r+\beta)a-1]\} + (1-K)/r(1-e^{-rl})]$$

YLD = years lost due to disability

DW= disability weight=0.29

K = age-weighting modulation constant (K=1)

C = age-weighting correction constant (GBDS standard value is 0.1658)

r = discount rate (GBDS standard value is 0.03)

a = age of onset

β = parameter from the age-weighting function (GBDS standard value is 0.04)

L = duration of disability (years) - 0.5 years

Results:

There were 30828 TB cases in Mumbai, between April 1, 2012 and March 31, 2013. Male TB patients outnumbered female (20024 [65%] vs. 10804 [35%]). The mortality pattern of tuberculosis in Mumbai shows that in year 2012-2013, there were total 214 deaths caused due to the TB, among these, six deaths occurred in 0-14 years age group, in this age group there were 4 male and 2 female children, maximum number of deaths occurred in 15-65 years age group, in this age group total 169 (78.97%) deaths caused due to tuberculosis and among that 112 (52.33%) were male and 57 (26.33%) were females. In elderly above 65 years there were total 39 deaths among which 25 are males and 14 were females. A total 30828 TB incidents occurred in year 2012-2013. In the calculation of disability adjusted life years (DALYs) overall, 2516.53 years of life got lost due to the tuberculosis in the population of Mumbai. Among these, total 324.48 DALYs were lost in age group of 0-15 year's population, in this population; male children lost 255.96 DALYs while female children lost 68.67 DALYs. Among the adult population in Mumbai, the total DALY lost was 1869 years and in this age group, males lost 1828.49 DALYs and females lost 42.12 DALYs. Among the elderly

population a total of 322.81 DALYs were lost and among these 313.69 DALYs were lost by male population and 9.12 DALYs were lost by females respectively.

Disability data-Years lived with disability (YLD)

Years lived with disability or poor health status contributes to major (83%) of the burden of TB. The overall burden of TB was greater among males since more males had and died with TB (50.6%) while female contribution was 33.5%.

Disability-adjusted life years (DALYs) lost in Mumbai

The mean TB burden from years-of-life-lost was 1.08 DALYs per patient. Of all YLL lost, 28% were lost due deaths in adult age group (15-54).

Conclusion

The current study found that mortality pattern due to tuberculosis was concentrated in working age (15-65 yrs) group and DALYs lost in Mumbai are also contributed by same working group. The contribution of mortality to burden of TB was 9.2% and these are avoidable deaths and its high proportion is a matter of great concern. The bulk of burden was shared by working age group of both sexes and particularly by the males. However, in terms of YLL females had nearly equal share which suggests equally high proportion of premature deaths (YLL) due to TB among women.

Limitation of the study:

This study is limited to Mumbai metropolitan only. This study does not account for wider socio- economic impact of TB and also effects of after TB sequel. Age specific mortality and incidence were not available so age specific proportions were calculated from using age specific death rates from Karnataka. Period of disability was taken 0.5 years for all cases.

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TABLE:

Table 1- TB mortality pattern

age	male	female	Male (L.E.)	Female (L.E.)
less than1	1	0	71.4	76.3
1-4	1	0	71	76.2
5-14	2	2	66	69.95
15-24	7	12	56	60.2
25-34	24	14	47	50.7
35-44	29	14	38	41.15
45-54	29	10	29	31.8
55-64	21	9	21	22.75
65-69	9	4	16	16.5
70+	15	10	14	12.9
Total	139	74		

Figure 1- Age Specific TB Mortality pattern in Mumbai.

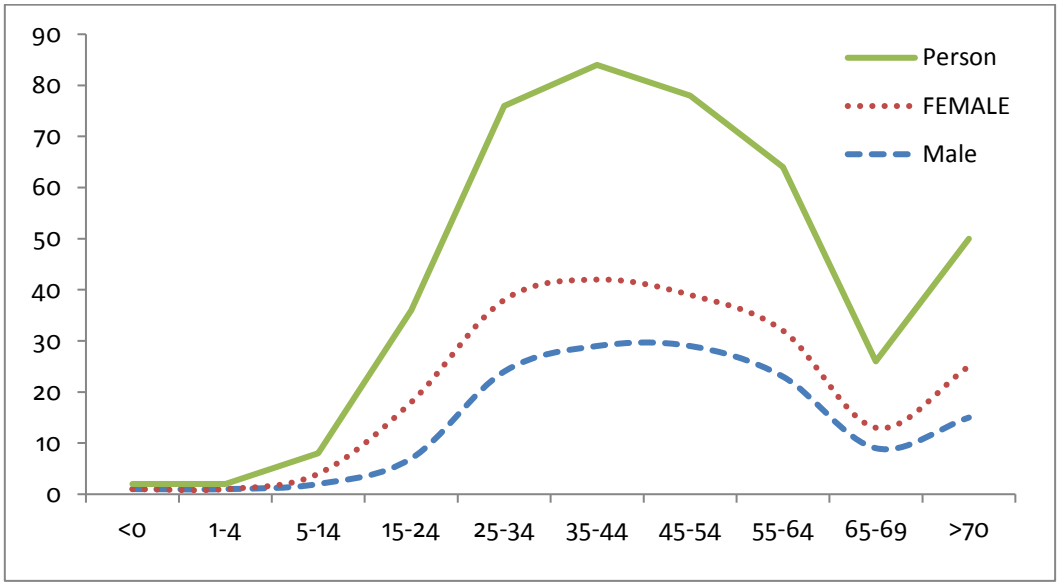

Table 2- TB cases incidence in Mumbai

	Male	Female	Total
Less than1	88	57	145
1 to 4	127	249	376
5 to 14	237	278	515
15 to 24	1018	1603	2621
25 to 34	3423	2003	5425
35 to 44	4215	1817	6032
45 to 54	4243	1454	5696
55 to 64	3258	1283	4540
65 to 69	1227	599	1826
>70	2190	1461	3651
Total	20024	10804	30828

Table 3 Disability-adjusted life years (DALYs) lost in Mumbai

	Deaths		**Life Expectancy**		**YLL**		**YLD**		**DALY**		**Total**
Age	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	
<1	1	0	71.4	76.3	32.91	32.70	0.64	0.64	76.84	33.35	110.18
0-4	1	2	71	76.2	26.14	25.92	0.55	0.55	92.83	26.48	119.30
5--14	2	2	66	69.95	8.73	8.54	0.30	0.30	86.29	8.84	95.14
15-24	7	11	56	60.2	4.34	4.61	0.10	0.10	127.96	4.71	132.66
25-34	24	14	47	50.7	9.39	9.69	0.01	0.01	252.25	9.70	261.96
35-44	29	13	38	41.15	10.14	10.48	0.05	0.05	526.06	10.54	536.60
45-54	29	10	29	31.8	8.76	9.15	0.07	0.07	550.99	9.22	560.21
55-64	23	9	21	22.75	6.57	6.88	0.07	0.07	370.73	6.95	377.67
65-69	9	4	16	16.5	4.88	4.97	0.06	0.06	117.86	5.04	122.90
70+	15	10	14	12.9	4.26	4.02	0.06	0.06	195.83	4.08	199.91
Total	139	75			116.11	116.98	1.92	1.92	2397.63	118.90	2516.53