

Estimation of the burden of diarrhoeal diseases in India

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Precise information about diarrhoea and its incidence, causation, consequences and trend is necessary for informed policy-making. As well informed people demand more health services and intervention than available resources can finance, decision-makers at all levels are increasingly required to identify diseases/health conditions based on sound and uniform methodologies for setting priorities in biomedical research and for rational allocation of limited resources to combat health menaces.

In 1993, the Harvard School of Public Health in collaboration with the World Bank and WHO assessed the global burden of disease (GBD). Aside from generating the most comprehensive and consistent set of estimates of mortality and morbidity by age, sex and region ever produced, GBD also introduced a new metric—disability-adjusted life-year (DALY)—to quantify the burden of disease. The use of DALY allows researchers to combine years of life lost (YLL) from premature death and years of life lived with disabilities into a single indicator.

DALYs for a disease or health condition are calculated as the sum of the YLL due to premature mortality in the population and the equivalent 'healthy' years lost due to disability (YLD) for incident cases of the condition.

To use time as a common currency for non-fatal health states and for YLL due to mortality, we must define, measure and numerically value time lived in the non-fatal health state. The 'valuation' of time lived in the non-fatal health state formalizes and quantifies social preferences for different health conditions as health state weights. Most such weights are measured on a scale of 0 to 1. Because the DALY measures loss of health, the weights are inverted for DALY calculation with 0 representing a state of optimal health (no loss) and 1 representing a state equivalent to death. The disability weights used for calculating DALYs quantify societal preferences for different health states. These weights do not represent the lived experience of any disability or health state, or imply any societal value of the person in a disability or health state. Rather, they quantify societal preferences for health states in relation to the societal 'ideal' of optimal health.

The DALY measures the future stream of healthy YLL

due to each incident case of disease or injury. It is thus an incidence-based measure rather than a prevalence-based measure. The GBD applied a 3% time discount rate to YLL in the future to estimate the net present value of years of life lost. With this discount rate, a year of healthy life gained in 10 years' time is worth 24% less than one gained now.

Discounting of future benefits is a standard practice in economic analysis and there are some specific arguments for applying discounting to the DALY in measuring population health.

YLD are the disability component of DALYs. Estimating YLD is the most difficult component of a GBD study. It will frequently require an in-depth understanding of the epidemiology of particular diseases to identify alternative estimation methods and will involve the use of judgement and creativity. The data required to estimate YLD are: incidence of disability, duration of disability, age of onset, and distribution by severity class, all of which must be disaggregated by age and sex. These, in turn, require estimates of incidence, remission, case-fatality rates or relative risks, by age and sex. With zero discounting and uniform age weights, the basic formula for calculating YLD is:

$$YLD = I \times DW \times L$$

where I is the number of incident cases in the reference period, DW is the disability weight (in the range of 0–1) and L is the average duration of disability (in years).

Data needed for estimation of the disease burden are:

- (i) General demographic estimates
- (ii) Cause-specific mortality proportion (CSMP)
- (iii) Descriptive epidemiological information
- (iv) Health state valuation in the community

Data sources for estimation of the diseases burden

Demographic data are available from Census of India 2001 and Sample Registration System (SRS). Causes of death are available from Survey of Causes of Death for rural areas (the procedure has been changed at present) and Medical Certification of Causes of Death (MCCD) for urban areas. Descriptive epidemiological data, i.e. incidence/

Table 1. Data used for estimation of the disease burden in India

	0–6 years		>6 years		Total	
	Rural	Urban	Rural	Urban	Rural	Urban
	122,336,460 (16.5% of rural)	35,493,735 (12.4% of urban)	619,323,833 (83.5% of rural)	249,861,219 (87.6% of urban)	741,660,293 (72.2%)	285,354,954 (27.7%)
Total	157,830,195 (15.4% of the total population)		869,185,052 (84.6% of the total population)		1,027,015,247	

Source: Census of India 2001

Table 2. Data used for estimation of burden due to diarrhoea in India

Indices	Current values (2001)	Projected values		
		2001–06	2006–11	2011–16
Total population (in crore)	102.7	109.41 (2006)	117.89 (2011)	126.35 (2016)
Life expectancy at birth (years)				
Male	62.30 (projected)	63.87	65.65	67.04
Female	65.27 (projected)	66.91	67.67	69.18

Source: Registrar General of India 1996

prevalence can be obtained from published/unpublished papers and reports. Summary measure of the disease burden provides an estimate of the disease burden in terms of YLL due to premature mortality, and also YLD due to the disease.

The general demographic data that have been used in the present estimation process (including the estimation of projected values for future years) are presented in Tables 1 and 2.

Data on morbidity, mortality and disability from diarrhoeal diseases

For estimation of the disease burden, incidence rather than prevalence data are useful. However, data on incidence are not easy to obtain, and thus, sometimes we have to depend on prevalence data. Of course, a number of community-based longitudinal studies from different parts of India are available, which show varied incidence data depending on situations in which the estimates were made. In the present estimation, the average value for such incidence data was used.

Data on mortality are required to calculate YLL component of DALYs. Similar to the morbidity data, literature search revealed wide variations in mortality estimates too in different studies and a declining trend over the years. We estimate deaths due to diarrhoea from reported values for age group-specific crude death rate (CDR) and proportionate mortality due to diarrhoea (Table 3).

To assess disability due to diarrhoea, we used the average of the common values reported for the duration of diarrhoea. Compared to morbidity and mortality, fewer studies reported the duration of diarrhoea. Most data on duration were obtained from hospital-based clinical trials, which were conducted under stringent experimental conditions,

and thus, the duration is likely to be less than that might occur under normal field conditions. The disability weight was obtained from the GBD estimation sources.

Estimation of YLL due to diarrhoea

$$\text{YLL} = (\text{Number of deaths}) \times (\text{Life expectancy at age X})$$

Table 3. Estimation of mortality due to diarrhoea in India

Crude death rate (India, rural)	= 9.3 per 1000 population
Total number of deaths	= 6,897,441
Total deaths in 0–6 years	= 1,517,437 (22% of total rural deaths)
Total deaths in >6 years	= 5,380,004 (78% of total rural deaths)
Crude death rate (India, urban)	= 6.3 per 1000 population
Total number of deaths	= 1,797,736
Total deaths in 0–6 years	= 221,122 (12.3% of total urban deaths)
Total deaths in >6 years	= 1,576,614 (87.7% of total urban deaths)
Total deaths (all ages; rural + urban)	= 8,695,177
Total 0–6 years deaths (rural + urban)	= 1,738,559
Proportionate mortality due to diarrhoea (all ages)	= 5.23% [SBHI, 2002]
Total diarrhoeal deaths (all ages)	= 454,758
Proportionate mortality due to diarrhoea (0–6 years)	= 9.1% [SBHI, 2002]
Total diarrhoeal deaths among 0–6 years	= 158,209
Total diarrhoeal deaths among 6+ years	= 296,549

Sources: Crude death rates. *Sample Registration System Bulletin*. 2001; 32. Age-specific death rates—Sample Registration System, 1998.

Note: The estimated total deaths due to diarrhoea are less than the estimation of 576,480 deaths by Zaidi *et al.* (2004)

Table 4. Life expectancy, India [SRS-based abridged life tables, 1988–92]

Age (years)	Life expectancy (years)
0 (at birth)	61.4
1	64.9
5	62.9
10	58.6
20	49.4
30	40.4
40	31.5
50	23.0
60	15.8
70	10.3

Table 5. Estimation of YLL due to diarrhoea

Age group (years)	Number of deaths due to diarrhoea	Life expectancy (years)	YLL (years)
0–6	158,209	62.9	9,951,346.1
>6	296,549	40.4 (at age 30)	11,980,579.6
Total			21,931,925.7

YLL = (Number of deaths) x (Life expectancy at age X)

Estimation of YLD due to diarrhoea

YLD = (Total number of episodes) × (Duration of each episode) × (Disability weight)

Table 6. Estimation of total diarrhoeal episodes

Area	Age group (year)	Population (2001)	Average estimated incidence (episodes/person/year)	Total number of episodes (per year)
Rural	0–6	122,336,460	1.71	209,195,347
	>6	619,323,833	0.63	390,174,015
Urban	0–6	35,493,735	1.09	38,688,171
	>6	249,861,219	0.33	82,454,202

Note: The average estimated incidences of diarrhoea in different populations and the average duration of each episode have been obtained by a review of incidence data from published and unpublished literatures (as listed in the Bibliography section) on diarrhoeal morbidity from different States of the country.

Table 10. Estimation of projected YLD

Year	No. of episodes in 0–6 years	No. of episodes in 6+ years	Average duration (years)	Average disability weight	YLD in 0–6 years	YLD in 6+ years	Total YLD
2006	264,531,498	499,828,644	0.01096	0.05	144,963.3	273,906.1	418,869.4
2011	285,034,442	538,568,676	0.01096	0.05	156,198.9	295,135.6	451,334.5
2016	305,489,030	577,217,340	0.01096	0.05	167,408.0	316,315.1	483,723.1

Table 11. Estimation of projected YLL

Year	Diarrhoea deaths in 0–6 years	Diarrhoea deaths in 6+ years	Life expectancy at 6 years	Life expectancy at 30 years	YLL in 0–6 years	YLL in 6+ years	Total YLL
2006	168,896	315,818	62.9	40.4	10,623,544.5	12,759,033.2	23,382,577.8
2011	181,986	340,296	62.9	40.4	11,446,939.6	13,747,942.9	25,194,882.5
2016	195,046	364,716	62.9	40.4	12,268,392.7	14,734,520.1	27,002,912.9

Duration of diarrhoeal episodes: 4 days (average) = 0.01096 years

Disability weight for diarrhoea: 0.02–0.12 (average 0.05) [from GBD estimates]

Table 7. Estimation of YLD due to diarrhoea

Area	Age group (years)	Total no. of episodes (per year)	Average duration of episodes (years)	Average disability weight	Estimated YLD (years)
Rural	0–6	209,195,347	0.01096	0.05	114,639.05
	>6	390,174,015	0.01096	0.05	213,815.36
Urban	0–6	38,688,171	0.01096	0.05	21,201.12
	>6	82,454,202	0.01096	0.05	45,184.90

Estimation of DALY due to diarrhoea

DALY = YLL + YLD

Table 8. Estimation of DALY

Age group	YLL (years)	YLD (years)	DALY (years)
0–6 years	9,951,346.1	135,840.2	10,087,186.3
>6 years	11,980,579.6	259,000.3	12,239,579.9
Total	21,931,925.7	394,840.5	22,326,766.2

From the estimated DALYs, it is observed that the YLL and YLD components account for 98.2% and 1.8% of total DALYs, respectively. According to Murray and Lopez (1996), more than 84% of the disease burden (from all diseases) among children in India was estimated to be due to premature mortality.

Projections

Table 9. DALYs lost due to diarrhoea: Projected values*

Year	Total population	0–6 years' population	>6 years' population
2006	1,094,100,000	168,491,400	925,608,600
2011	1,178,900,000	181,550,600	997,349,400
2016	1,263,500,000	194,579,000	1,068,921,000

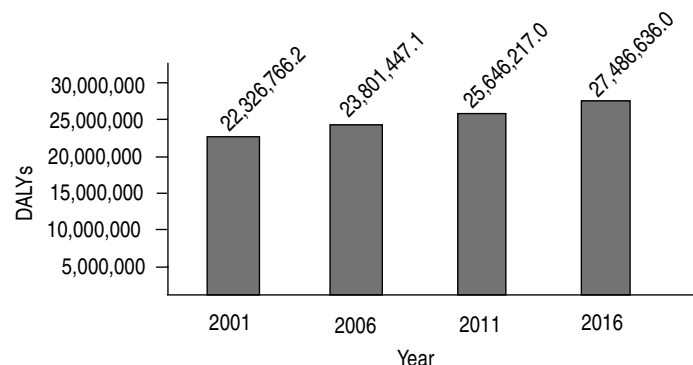
*Based on the population projections in Table 2

Note: We assume similar age distribution (as shown for 2001) of projected populations.

Table 12. Estimation of projected DALY

Year	YLL	YLD	DALY
2006	23,382,577.8	418,869.4	23,801,447.1
2011	25,194,882.5	451,334.5	25,646,217.0
2016	27,002,912.9	483,723.1	27,486,636.0

DALY: disability-adjusted life-year; YLL: years of life lost; YLD: years lost due to disability

**Fig. 1** Diarrhoeal diseases in India: Estimated DALYs lost (current and projected)

DALY: disability-adjusted life-year

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