RESEARCH COMMUNICATION

Disability Adjusted Life Years for Cancer Patients in India

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Abstract

The disability adjusted life year (DALY) has been employed to quantify the burden of diseases. This measure allows for combining in a single indicator "years of life lived with disabilities (YLD)" and "years of life lost from premature death (YLL)". The present communication attempts to estimate the burden of cancers in-terms of YLL, YLD and DALY for "all sites" and leading sites of cancer in India for the years 2001, 2006, 2011 and 2016. The YLL, YLD and DALY were estimated by employing Global Burden of Disease (GBD) methodology using the DISMOD procedure. The published data on age, gender and site specific cancer incidence and mortality for the years 2001-2003 relating to six population-based cancer registries viz. Bangalore, Barshi, Bhopal, Chennai, Delhi and Mumbai, expectation of life by gender for urban areas of the country for 1999-2003 and the projected population during years 2001, 2006, 2011 and 2016 were utilized for the computations. DALYs were found to be lower for males (2,038,553, 2,313,843, 2,656,693 and 3,021,708 for 2001, 2006, 2011 and 2016 respectively) as compared to females (2,560,423, 2,961,218, 3,403,176 and 3,882,649). Amongst males, highest DALYs were contributed by cancer of the lung and esophagus while in females they were for cancers of breast and cervix uteri. It is estimated that total DALYs due to cancer in India combined for both genders would increase from 4,598,976 in 2001 to 6,904,358 by 2016. Premature mortality is a major contributor to disease burden. According to the present estimates, the YLL component of DALY is about 70.0%. The above described computations reveal an urgent need for initiating primary and secondary prevention measures for control of cancers.

Keywords: Cancer burden - India - DALYs

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Introduction

The burden of cancer is increasing worldwide despite advances in diagnosis and treatment. Globally, the burden of new cancer cases in 2002 was estimated to be around 10.9 million, developing world contributing to 53% of this load (Parkin et al., 2005). Rising longevity, alterations in life styles and progressive control of communicable diseases has led to emergence of cancer and non-communicable diseases as an important health problem in India and other developing countries. In India, the life expectancy at birth has steadily risen from 49.7 years in 1973 to 62.7 years in 2001, indicating a shift in demographic profile (SRS, 2006). It is expected that life expectancy of Indian population will increase to 70 years by 2021-25 (Registrar General of India, 1996). There will be a substantial rise in the proportion of elderly people (60+) in the country. In-terms of absolute numbers, the increase will be from 14 millions as recorded during the year 1971 to 113 millions in the year 2016 (SRS, 1998). Due to such changes in age structure, increasing expectation of life and marked changes in life styles (tobacco and excessive alcohol consumption, obesity and physical inactivity), population would face an increase in incidence of cancers and some other non-communicable diseases, which have a higher chance of occurrence among elderly. Aging population is one of the single most important factors for cancer development. It is estimated that by 2015, two thirds of all cancer cases will occur in developing world. With this scenario of the health situation, it is important to study the burden of cancer in-terms of: years lived with disease and years of life lost, future projections using Indian data to understand the real dimensions of the problem and also work towards preventive measures. Such attempts would help in strengthening the scientific and empirical basis for planning and to formulate sound cancer control strategies.

Burden of disease can be assessed through a number of epidemiological parameters such as incidence, prevalence, disease specific mortality, and disability caused by the disease. World Development Report 1993 with the title Investigating in Health (World Bank, 1993) presented sophisticated epidemiological parameters like YLD (years of life lived with disability) and disability adjusted life years (DALY) for different regions of the world as a measure of global burden of disease. DALY combines information on morbidity, mortality and

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disability to provide a composite index of burden of disease. A comprehensive assessment of disease burden at national level would provide insights at the level of both organizations and individuals who are committed to health policy and also for evaluation of National Cancer Control Program (NCCP) being launched by Government of India.

The present communication attempts to estimate the burden of cancers in-terms of years of life lost due to premature mortality by cancer (YLL), years of life lived with disease (YLD) and disability adjusted life years (DALY) by age, gender and leading sites of cancer in India.

Materials and Methods

To estimate the burden of disease (BOD) due to cancer in terms of YLL, YLD and DALYs at the national level and for its further projections the specific data requirements are age & gender-wise; (i) incidence & mortality rates of cancer (ii) general mortality rate due to all causes at national level and (iii) projected population of the country. In the present analysis the estimates of YLD and DALY due to cancer have been estimated based on published data of (a) cancer incidence and mortality data of population based cancer registries (PBCRs) of Indian Council of Medical Research (ICMR), (b) projected population data of the country for the various years 2001, 2006, 2011 and 2016 and (c) general mortality data due to all causes at national level for urban areas of the country as five of the six PBCRs used in the present analysis are located in urban areas.

i) Estimation of pooled cancer incidence and mortality rates

The data on occurrence of cancer in the country is available from the PBCRs established in the various parts of the country by the ICMR. The data of earlier established six PBCRs- located at Bangalore, Barshi, Bhopal, Chennai, Delhi and Mumbai for the year 2001-2003 was used for "all sites" and various sites of cancer for estimating the pooled incidence and mortality rates representing national level estimates. The six PBCRs covered a population of 38.4 millions that is 20.8 million males and 17.6 million females (NCRP, 2006).

Published report of NCRP for the period 2000-2004 contained data for six PBCRs viz. Bangalore, Barshi, Bhopal, Chennai, Delhi and Mumbai on the incidence & mortality rates by age, gender and site of cancer. It also contained data on the age & gender-wise mid year population for these cities (NCRP, 2006). The number of cancer cases by site, gender and five-year age group for each of the registries was obtained by multiplying the age-specific-incidence rates with the respective five-year populations. The respective annual number of incident cases and deaths thus obtained through the above step were summed-up for all the registries to get the total number of cases in each five-year age group by site and gender. The annual populations of all the above six registries by age and gender in the respective five-year age groups were added-up to obtain the total population for all the registries. The pooled age-specific incidence rates of cancer by site, age and gender for all the six registries were obtained by dividing the respective pooled number of cases with the corresponding pooled population.

ii) Population of the country

Population of the country according to age and gender by different quin-quennial years from 2001 to 2016 were obtained from the report of population projections carried out for the country for the years 1996 to 2016 by the Registrar General of India (1996).

iii) Estimation of general mortality data at the national level

The sample Registration System (SRS) is the main source of information on fertility and mortality in India. The SRS mechanism involves collection of data through two independent methods, viz., continuous enumeration and retrospective surveys followed by a process of matching of the two records and field verification of the unmatched and partially matched events. This process ensures a crosscheck of the correctness and completeness of the recording of births and deaths from the two methods. The abridged life tables for the year 1999-2003 being published by the Registrar General of India, based on SRS was utilized for getting the all causes mortality and the expectation of life at various age intervals by gender and residential status (SRS, 2006).

iv) Estimation of YLD, YLL and DALY

In the present study YLD, YLL and DALY have been estimated by employing the methodology suggested in the Global Burden of Disease (GBD) study (DISMOD procedure) conducted by WHO (Murray 1994; Murray and Lopez 1996; Murray and Lopez 1997a, b). In the DISMOD procedure it has been assumed that there are two causes of death: from the disease under study and from all other causes, which are assumed to be independent. With the above assumption it has been shown that the disease model can be completely determined by the three- transition hazards viz. incidence, remission and case fatality (DISMOD I). However, for diseases like cancer, information on remission is difficult to obtain. In such situation, when input variable like prevalence is known, DISMOD II has been suggested to be more useful. DISMOD II has been modified to allow for a wider range of disease input variables than the three transitional hazards such as incidence, remission and case fatality employed under DISMOD I. In particular, disease incidence, disease specific mortality are input variables. In addition to disease input variables, DISMOD II needs total general mortality rate and population number for the population under study. All the calculations are done separately for men and women. When the information relating to these variables are entered in DISMOD II, the programme inserts these values in the equations, and calculates the epidemiologic variables and compares them with the input variables and produces the required results. In the present analysis, DALY Template of WHO was employed for estimating YLD, YLL and DALY for "all sites of cancer" as well as for the various leading sites of cancer (htpp// www//the global burden of disease, 1996, accessed on 3rd March, 2009).

Assumptions

The projection of estimation of DALY due to cancer have been done with the following assumption (i) pooled incidence and mortality rates obtained from the six PBCRs represent country's incidence & mortality rate due to cancer (ii) age-specific cancer incidence rates & mortality rates due to cancer as well as general mortality rate will remain unchanged over the next 15 years from 2001 till 2016.

Results

The estimates of burden of disease due to cancer in India have been made based on data of earlier established PBCRs working under the network of NCRP of ICMR. The pooled estimates of cancer incidence & mortality data of all the six registries were found to be 70.8, 84.2 and 23.4 and 23.0 per 100,000 populations for males and females respectively (Table 1). The cancer incidence (89.7 and 94.9 for males and females respectively) and mortality rates (38.6 and 32.4 for males and females, respectively) in Chennai registry was higher as compared to other registries. The rural registry of Barshi had recorded the lowest incidence rate of cancer, while the Delhi registry had recorded the lowest cancer mortality rate. The expectation of life at various ages for urban Indian population for the year 1999-2003 was based on SRS (Table 2). The expectation of life during infancy was 68.1 years for both sexes. The population of the country during the 5 year periods 2001, 2006, 2011 and 2016 has been reported to be 532,156,000; 572,530,000; 617,315,000; and 657,167,000 for males and 496,454,000; 536,658,000; 575,188,000 and 611,792,000 for females (Table 3). The DISMOD analysis and estimation of DALY for "all sites of cancer" has revealed that the total number of DALYs attributable to cancer in India in the year 2001 was estimated to be 2,038,553 and 2,560,423 amongst males & females respectively. As per the present analysis, this would get increased to 3,021,708 and 3,882,649 by 2016 amongst males and females respectively merely as a result of increasing longevity and population size (Table 4). Females had higher DALYs as compared to males. Amongst males, cancer of oral cavity followed by cancer of lung, esophagus, stomach, colon & rectum and liver. While in females, cancer of breast followed by reproductive organs and oral cavity. Even in terms of DALYs per 100,000 population, higher number of DALYs was observed for females as compared to males (Table 5). Similar pattern of results were noted for DALYs per 100,000 populations as that of earlier table. A comparison of burden of disease by WHO study for the year 2000, ICMR study results for the year 2004 and present study results for the years 2001, 2006, 2011 and 2016 are shown in Table 6. The ICMR study reported DALYs of 58, 97, 000 for the year 2004 while the WHO study for the year 2000 itself estimated 8,658,670. The findings of the present study for the year 2001 was found to be 4,598,976. This estimate is low as compared to the estimate of WHO as well as that of ICMR. Based on the present study it is estimated that DALYs due to cancer in India combined for both gender would get increased from 4,598,976 in 2001 to 6,904,358 by 2016 (Table 6). Premature mortality is a major contributor to the disease burden. The results of the present study indicated that for "all sites of cancer" YLL contributed to 70% of total DALYs (Table 7). However, there was wide variation of YLL to DALYs and ranged from 38% to 98.5% for various sites of cancer.

Table 1. Cancer Incidence and Mortality Rates (all sites) in 2001-2003 in India

PBCR	Incidence (Crude Rate)		Mortality (Crude Rate)	
	Male	Female	Male	Female
Bangalore	65.0	85.0	23.7	22.4
Barshi [@]	40.6	49.4	31.9	36.1
Bhopal	65.2	64.2	18.1	16.4
Chennai	89.7	94.9	38.6	32.4
Delhi	71.6	81.5	9.0	7.6
Mumbai	67.4	83.7	34.4	34.4
Pooled for all registries[a]	70.8	84.2	23.4	23.0

@ Rural registry; [a] Pooling was done by considering age and sex-wise distribution of population of individual registry along with age and sex-wise distribution of cancer incidence rates for the year 2001-2003. [+] Source: NCRP (2006)

Table 2. Expectation of Life (years) for Urban Indian Population by Age, 1999-2003

Age Interval	Total	Male	Female
0-1	68.1	66.5	69.4
1-4	70.2	68.6	71.5
5-10	67.6	65.4	69.4
10-15	62.9	60.6	64.8
15-20	58.1	55.8	60.0
20-25	53.5	51.1	55.4
25-30	48.8	46.5	50.8
30-35	44.3	41.9	46.2
35-40	39.8	37.5	41.7
40-45	35.4	33.2	37.1
45-50	31.0	28.9	32.6
50-55	26.8	24.8	28.1
55-60	22.9	21.0	24.0
60-65	19.3	17.6	20.2
65-70	16.1	14.5	16.6
70+	13.2	11.9	13.5

Source: SRS based abridged life tables, 1999-2003 (2006).

Discussion

The Global Burden of Disease (GBD) study introduced a new metric-disability adjusted life year (DALY)-to quantify the burden of disease. DALY helps to combine information on morbidity, mortality and disability to provide a composite index of burden of disease. DALYs contains two major components-the years of life lost (YLL) due to premature mortality and the years of life lost due to disability (YLD). The use of DALY allows combining in a single indicator years of life lost (YLL) from premature death and years of life lived with

Table 3. Age and Gender-Wise Distribution of Population of the Country: 2001-2016

Age (Yrs)	Year			
Males	**2001**	**2006**	**2011**	**2016**
0-4	62,623,000	60,910,000	60,745,000	60,353,000
5-14	127,400,000	125,485,000	121,410,000	119,825,000
15-29	144,099,000	164,041,000	179,839,000	185,729,000
30-44	103,367,000	109,906,000	123,418,000	138,714,000
45-59	59,725,000	71,442,000	83,765,000	94,435,000
60-69	22,635,000	24,537,000	28,684,000	35,365,000
70-79	12,307,000	16,209,000	19,454,000	22,746,000
Total	532,156,000	572,530,000	617,315,000	657,167,000
Females				
0-4	58,772,000	54,329,000	54,133,000	53,748,000
5-14	115,787,000	116,274,000	110,653,000	106,364,000
15-29	133,914,000	148,026,000	161,882,000	169,860,000
30-44	97,960,000	110,363,000	119,710,000	129,487,000
45-59	54,278,000	64,832,000	78,478,000	92,347,000
60-69	23,570,000	25,411,000	28,118,000	33,618,000
70-79	12,173,000	17,423,000	22,214,000	26,368,000
Total	496,454,000	536,658,000	575,188,000	611,792,000

Source: Registrar General of India (1996).

Table 4. Site- Specific Burden of Cancer (DALY) by Gender and Period

Sites	Male				Female			
	2001	**2006**	**2011**	**2016**	**2001**	**2006**	**2011**	**2016**
Esophagus	106,616	124,005	146,130	170,593	76,805	90,330	105,922	123,404
Stomach	94,590	108,479	127,184	147,528	62,218	71,993	83,503	96,572
Liver	75,315	86,287	100,454	116,635	39,423	46,235	53,846	62,271
Pancreas	37,046	42,778	50,181	58,282	24,026	28,473	33,333	38,740
Breast	5,720	6,444	7,478	8,635	811,298	943,689	1,088,642	1,244,773
Cervix uteri	-	-	-	-	345,138	403,867	468,776	539,279
Corpus Uteri	-	-	-	-	39,242	45,473	53,055	61,910
Ovary	-	-	-	-	183,196	211,521	243,050	276,909
Prostate	43,033	53,682	64,263	76,362	-	-	-	-
Bladder	38,273	44,138	51,463	59,826	10,400	12,447	14,788	17,456
Oral cavity	549,025	629,634	731,154	837,837	192,139	225,008	261,988	302,460
Colon & Rectum	79,065	91,122	105,932	121,043	69,857	82,491	96,177	110,851
Lung	169,008	195,139	229,139	267,468	65,434	76,726	89,928	104,791
Melanoma & Other Skin	26,025	29,661	34,161	38,767	14,380	17,080	20,010	23,122
Lymphoma &. Multiple Myeloma	130,612	144,826	162,989	181,969	76,131	87,073	98,480	110,678
Leukaemia	219,446	234,429	250,628	264,988	152,114	163,951	174,578	184,925
Other Cancers	464,779	523,219	595,537	671,775	398,622	454,861	517,100	584,508

disabilities (YLD).

The data requirement for computation of DALYs is enormous. Many developing countries do not generate data of that kind. The needs are particularly intense for computing YLD component. The data requirement includes incidence, prevalence, duration of disease, case-fatality and remission rates of each site of cancer in different age-sex groups separately for each severity condition of the cancer site. In the absence of readily available data, workable estimates can be derived by (i) review of epidemiological literature, (ii) using epidemiological models and (iii) consulting experts. In the absence of all such data the weights derived by the Harvard School of Public Health, World Health Organization and the World Bank for different sites of cancer can be employed.

The data requirement for YLL component on the other hand is relatively mild. Estimates of years of life lost

Table 5. Site- Specific Burden of Cancer by Gender and Period-DALYs per 100,000 Populations

Sites	Male				Female			
	2001	2006	2011	2016	2001	2006	2011	2016
Esophagus	20	21.7	23.7	26	15.5	16.8	18.4	20.2
Stomach	17.8	18.9	20.6	22.4	12.5	13.4	14.5	15.8
Liver	14.2	15.1	16.3	17.7	7.9	8.6	9.4	10.2
Pancreas	7	7.5	8.1	8.9	4.8	5.3	5.8	6.3
Breast	1.1	1.1	1.2	1.3	163.4	175.8	189.3	203.5
Cervix uteri					69.5	75.3	81.5	88.1
Corpus Uteri					7.9	8.5	9.2	10.1
Ovary					36.9	39.4	42.3	45.3
Prostate	8.1	9.4	10.4	11.6				
Bladder	7.2	7.7	8.3	9.1	2.1	2.3	2.6	2.9
Oral cavity	103.2	110	118.4	127.5	38.7	41.9	45.5	49.4
Colon & Rectum	14.9	15.9	17.2	18.4	14.1	15.4	16.7	18.1
Lung	31.8	34.1	37.1	40.7	13.2	14.3	15.6	17.1
Melanoma & Other Skin	4.9	5.2	5.5	5.9	2.9	3.2	3.5	3.8
Lymphoma &. Multiple Myeloma	24.5	25.3	26.4	27.7	15.3	16.2	17.1	18.1
Leukemia	41.2	40.9	40.6	40.3	30.6	30.6	30.4	30.2
Other Cancers	87.3	91.4	96.5	102.2	80.3	84.8	89.9	95.5
Total (All Cancers)	383.2	404.2	430.3	459.7	515.6	551.8	591.7	634.6

Table 6. DALYs Attributed to Cancer (site-wise) According to WHO Burden of Disease Study (2000), ICMR Study 2004 and Present Study (2001–2016)

Site of cancer	WHO BOD study, 2000, No of DALYs+	ICMR Study, No of DALYs, 2004+	Present study, No of DALYs			
			2001	2006	2011	2016
Oral cavity	1,095,190	679580	741,164	854,643	993,142	1,140,297
Oesophagus	596,593	246178	183,421	214,335	252,052	293,997
Stomach	376,571	247041	156,808	180,472	210,687	244,101
Colon & Rectum	303,024	195428	148,921	173,613	202,109	231,894
Liver	330,692	111618	114,738	132,523	154,300	178,907
Pancreas	111,317	63680	61,072	71,250	83,513	97,023
Lung	1,102,419	192841	234,443	271,865	319,067	372,259
Melanoma & Other Skin	22,084	44078	40,405	46,741	54,171	61,889
Breast	646,034	889761	817,018	950,133	1,096,120	1,253,408
Cervix	933,489	431538	345,138	403,867	468,776	539,279
Corpus uteri	22,401	63661	39,242	45,473	53,055	61,910
Ovary	170,861	227088	183,196	211,521	243,050	276,909
Prostate	165,280	62805	43,033	53,682	64,263	76,362
Bladder	242,094	61744	48,672	56,585	66,251	77,281
Lymphoma &. Multiple Myeloma	1,012,055	252593	206,743	231,899	261,469	292,647
Leukemia	679,205	387744	371,560	398,380	425,206	449,912
Other Cancers	614,183	1739622	863,402	978,081	1,112,637	1,256,283
Total (All Cancers)	8,658,670	5,897,000	4,598,976	5,275,063	6,059,868	6,904,358

+ Sources: Assessment of Burden of Diseases, ICMR, 2006

(YLL) can be computed for various populations based on the age, gender and site-specific cancer mortality rates and the abridged life tables providing expectation of life for the corresponding period and to the related population. In cancer, disability of various severities is caused according to the affected site of cancer and for different duration. Weights are given according to their severity and converted to loss of life. This allows comparison of one DALY lost in a group of persons due to a particular condition like "lung cancer" with the one

Table 7. YLD and YLL by Sites of Cancer During the Period 2001-2016

Site	2001		2006		2011		2016		2001	%YLL to
Esophagus	**YLD**	**YLL**	**YLD**	**YLL**	**YLD**	**YLL**	**YLD**	**YLL**	**YLD+YLL**	**DALYS**
Males	1,591	105,026	1,851	122,154	2,165	143,965	2,516	168,077	106,617	98.51
Females	776	76,029	911	89,418	1,064	104,858	1,238	122,166	76,805	98.99
Stomach										
Males	2,086	92,504	2,408	106,071	2,805	124,379	3,249	144,279	94,590	97.79
Females	896	61,322	1,048	70,945	1,217	82,286	1,406	95,167	62,218	98.56
Liver										
Males	819	74,496	938	85,349	1,083	99,372	1,245	115,390	75,315	98.91
Females	272	39,151	311	45,924	354	53,492	401	61,870	39,423	99.31
Pancreas										
Males	427	36,620	496	42,282	577	49,604	667	57,615	37,047	98.85
Females	202	23,824	237	28,236	274	33,059	315	38,425	24,026	99.16
Breast (F)	504,576	306,722	583,699	359,990	668,052	420,590	758,527	486,246	811,298	37.81
Cervix Uteri	180,990	164,148	211,964	191,903	244,709	224,067	280,139	259,140	345,138	47.56
Corpus Uteri	24,102	15,140	28,024	17,449	32,652	20,403	37,875	24,035	39,242	38.58
Ovary	83,584	99,611	95,974	115,547	109,356	133,694	123,659	153,250	183,195	54.37
Prostate	5,936	37,097	7,015	46,667	8,256	56,007	9,706	66,656	43,033	86.21
Urinary Bladder										
Males	7,437	30,835	8,537	35,602	9,900	41,563	11,388	48,438	38,272	80.57
Females	1,847	8,553	2,130	10,316	2,457	12,331	2,828	14,628	10,400	82.24
Oral Cavity										
Males	336,369	212,656	385,715	243,919	446,262	284,892	509,638	328,198	549,025	38.73
Females	105,202	86,936	123,121	101,888	142,836	119,153	164,192	38,269	192,138	45.25
Colon & Rectum										
Males	4,895	74,170	5,544	85,578	6,355	99,577	7,185	113,858	79,065	93.81
Females	11390	58466	13,164	69,327	15,091	81,086	17,131	93,719	69,856	83.70
Lung										
Males	4,258	164,751	4,947	190,192	5,788	223,351	6,751	260,716	169,009	97.48
Females	1,007	64,427	1,184	75,542	1,382	88,545	1,610	103,181	65,434	98.46
Skin										
Males	15,413	10,612	17,530	12,131	20,109	14,052	22,783	15,984	26,025	40.78
Female	7,487	6,894	8,967	8,112	10,557	9,452	12,204	10,918	14,381	47.94
Lymphoma										
Males	6,192	124,421	6,927	137,899	7,772	155,217	8,649	173,320	130,613	95.26
Females	3,006	73,125	3,452	83,621	3,928	94,552	4,448	106,229	76,131	96.05
Leukaemia										
Males	4,165	215,281	4,473	229,956	4,813	245,815	5,140	259,848	219,446	98.10
Females	2,227	149,886	2,413	161,538	2,589	171,989	2,767	182,158	152,113	98.54
Other cancers										
Males	15,888	448,891	17,948	505,272	20,357	575,180	22,886	648,889	464,779	96.58
Females	18,936	379,687	21,427	433,434	24,026	493,074	26,673	557,835	398,623	95.25
All sites	1,351,976	3,247,000	1,562,355	3,712,708	1,796,786	4,263,082	2,047,216	4,857,142	4,593,257	70.57

lost due to malignant neoplasm of stomach. Although, DALYs may not be the final word on measurement of physical component of health but this has at least initiated some discussion on criteria for setting health priorities for different segments of population.

The GBD study has calculated the DALYs for India for the year 1990 and has projected till 2020 (Murray & Lopez, 1996). The ICMR has estimated DALYs for the years 1998 and 2004 (ICMR, 1996). However, based on the incidence & mortality data of six PBCRs and its projections till 2016 have not been attempted by any researchers till date. Such types of summary measure with a future projection is essential for setting priorities for health planning, public health programs, research and development. These summary measures also help to identify the relative magnitude of different health

problems, including diseases, injuries and risk factors.

The present study was undertaken to quantify the burden of premature mortality and disability by age and sex, at national level for "all sites" and major leading sites of cancer using the GBD methodology using existing information. GBD measures the population health status by using the Potential Years of life lost due to Premature Mortality (YLL) and Years of life lived with Disability adjusted for severity of disability (YLD). Measures of potential years of life lost due to premature mortality have been used for many years to measure the mortality burden of various causes of death (Indrayan et al., 2002; Murthy et al., 2002). All these measure the gap in years between age at death and some arbitrary standard age or with expectation of life at death.

The estimates of total number of DALYs attributable to cancer in the present investigation are 4,598,976 during 2001 and would get increased to 6,904,358 by 2016 as a result of increase in size of population and due to aging of the population. The estimates of the present study are lower compared to the estimates made by the WHO-GBD study (8,658,670 for 2000) and ICMR study for the year 1998 (5,393,000) (Mathers et al., 2002; ICMR, 2006). This difference in DALYs could be due to difference in mortality rates used in these three studies. Premature mortality is a major contributor to disease burden. According to the estimates of World Bank-WHO study on GBD (Murray and Lopez, 1996) the YLL component of DALY is around 50% in established market economics where the epidemic transition has already taken place. In our study the YLL contribution to DALYs is around 70% for all sites of cancer. In the Sub-Saharan Africa, more than 75% of DALYs was contributed by YLLs (ICMR, 2006). It may be mentioned that estimation of burden of disease is highly dependent on estimates of disease specific mortality.

The present study employed the cancer mortality rates obtained by pooling the data of six PBCRs. There are certain limitations in the collection of mortality data in India. The system of registration of death and certification of the cause of death suffers from many limitations. Though, in urban centers all deaths are generally registered, information on the cause of death is lacking. When cancer is mentioned as a cause of death, the anatomical site is not mentioned and when the site is mentioned, the histology or morphology is not stated. Because of this, there are difficulties in having a clear and complete picture of cancer mortality as opposed to cancer morbidity. The cancer mortality rates among six PBCRs vary widely. Amongst males, the highest being for Chennai Registry (38.6 per 100,000 males), while amongst women Barshi registry had the highest rate (36.1 per 100,000 females). Bangalore, Bhopal and Delhi registries have reported slightly low cancer mortality rates. Traditionally, Mumbai has developed a relatively better system of registration mainly because of the earlier efforts such as Coroners act. Chennai registry and recently, Bhopal have made some special efforts to improve the coverage of mortality data through home visits. Other cancer registries have made no special efforts of making home visits to ensure complete coverage. Therefore figures of cancer mortality as presented by these registries may under estimate of the true cancer rates.

The other sources of cause specific mortality data in the country are from (i) Medical Certification of Causes of Death (MCCD) obtained from hospitals mostly from urban areas and Survey on Causes of Death (SCD) from rural areas. Both MCCD and SCD data provides cancer deaths as a percentage of total deaths. As per MCCD data nearly 3.0% and 3.4% accounts for cancer deaths to total deaths for males and females respectively. Similarly, as per Survey of Cause of Death for reports from rural areas, nearly, 4.3% forms as cancer deaths to total deaths. The data from the above sources were not utilized due to various limitations. However, a number of efforts are under way to improve cause of death statistics in the country. It is expected that more reliable data on cause of death will become available in future and this will help in further improvements in estimates of burden of disease due to cancer. Both these estimates are low as compared to the estimate of 85.59 lakh DALYs reported by WHO burden of disease study for the year 2000. It may be also indicated that in India, during the year 2001, nearly 0.80 million new cancer cases were estimated and this would increase to 1.22 million by 2016 as a result of change in size and composition of population. The estimated cases were more for females (0.406 millions, 2001) than males (0.392 millions, 2001) (Murthy et al, 2009).

The above computations reveal the burden of cancer and the urgent need for initiating primary and secondary prevention measures for control of cancers.

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