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Original Article

Community Medicine Section

Competing Risk Approach (CRA) for Estimation of Disability Adjusted Life Years (DALY's) for Female Breast Cancer in India

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ABSTRACT

Background: Competing Risk Approach (CRA) has been used to compute burden of disease in terms of Disability Adjusted Life Years (DALYs) based on a life table for an initially disease-free cohort over time.

Objective: To compute Years of Life Lost (YLL) due to premature mortality, Years of life lost due to Disability (YLD), DALYs and loss in expectation of life (LEL) using competing risk approach for female breast cancer patients for the year 2008 in India.

Materials and Methods: The published data on breast cancer by age & sex, incidence & mortality for the year 2006-2008 relating to six population based cancer registries (PBCR) under Indian Council of Medical Research (ICMR), general mortality rates of 2007 in India, published in national health profile 2010; based on Sample Registration System (SRS) were utilized for computations. Three life tables were constructed by applying attrition of factors: (i) risk of death from all causes ('a'; where a is the general death rate); (ii) risk of incidence and that of death from causes other than breast cancer ('b-a+c'; where 'b' is the incidence of breast cancer and 'c' is the mortality of breast cancer); and (iii) risk of death from all other causes after excluding cancer mortality ('a-c'). Taking the differences in Total Person Years Lived (TPYL), YLD and YLL were derived along with LEL.

Results: CRA revealed that the DALYs were 40209 per 100,000 females in the life time of 0-70+ years with a LEL of 0.11 years per person. Percentage of YLL to DALYs was 28.20% in the cohort.

Conclusion: The method of calculation of DALYs based on the CRA is simple and this will help to identify the burden of diseases using minimal information in terms of YLL, YLD, DALYs and LEL.

Keywords: Burden, Mortality, Probability

INTRODUCTION

Worldwide, the number of cancer cases is steadily increasing over the years. Globally, the burden of new cancer cases in 2012 was 14.1 million [1]. In 2012 globally, 1.7 million women were diagnosed with breast cancer and there were 6.3 million women alive who had been diagnosed with breast cancer in the previous five years [2]. Breast cancer ranks second in the South East Asia region according to the number of deaths, by cancer site and region. Among Indian females, breast cancer is one of the most common cancers according to latest reports available from National Cancer Registry Program (NCRP) [3]. According to the recently published report of NCRP, deaths due to breast cancer in India will increase to 106,124 in 2015 and 123,634 in 2020 respectively [4]. Several epidemiological parameters such as incidence, prevalence, disease specific mortality and disability caused by the disease have been suggested for assessing the burden of the disease in a Community [5]. DALY is estimated by adding the number of years of life a person loses as a consequence of dying early because of the disease (YLL); and the number of years of life a person lives with disability caused by the disease (YLD). The World Development Report 1993 which was titled 'Investigating in Health' presented sophisticated epidemiological parameter– 'Disability adjusted life years (DALY) for different regions of the world' as a measure of global burden of disease [6]. DALYs combines information on morbidity, mortality and disability to provide a composite index for burden of disease. Method of assessing burden of a disease using DALYs is the most conventional approach. However, DALY can be seen in parallel to the competing risk theory of loss and gain which uses life table technique. Death is one of the most important and unavoidable vital event. Various 'risks' compete for the life of an individual as death is not attributed to a single cause therefore, studying loss or gain, namely, person years of life lost and cause elimination is essential. CRA is based on this hypothetical situation "how many years can life expectancy of a population can be increased if a particular cause of death is removed from that population" [7]. The theory of competing risk is based on the cause elimination method i.e. the probability of death from other causes rises when one particular cause of death is eliminated. Data requirement for computation of DALYs using Global Burden of Disease (GBD) is enormous; hence an alternative method using competing risk is attempted in the present study to estimate the burden of breast cancer in-terms of DALYs and LEL using competing risk approach for female breast cancer for the year 2006- 2008 in India.

AIM

To estimate YLL, YLD, DALY's and loss of expectation of life (LEL) at the national level employing the competing risk approach (CRA).

MATERIALS AND METHODS

The specific data requirements were: (i) age specific general mortality rate at the national level for the year 2007 (denoted as 'a') obtained from National Health profile 2010 published by Central Bureau of Health Intelligence based on Sample Registration System [8]; (ii) incidence of breast cancer (denoted as 'b'); & (iii) mortality rates of breast cancer (denoted by 'c') obtained from Population Based Cancer Registries (PBCRs) under Indian Council of Medical Research (ICMR) during the year 2006-2008 [9].

Methods of estimation of pooled cancer incidence and mortality rates at national level: The data on the occurrence of breast cancer as available from the PBCRs of earlier established six PBCRs- located at Bangalore, Barshi, Bhopal, Chennai, Delhi and Mumbai for the year 2006-2008 was used for estimating the pooled incidence and mortality rates by age and sex wise [9].

The age-specific-incidence rates with the respective five-year female populations for each of the PBCRs were multiplied to obtain the number of breast cancer cases. The number of incident cases and deaths from breast cancer for that year were summed-up for all the registries to get the total number of cases in each five-year age group. Total population of all the registries were obtained by adding the annual populations of all the above six registries in the respective five-year age groups. Pooled number of cases was divided with the corresponding pooled population to obtain pooled age-specific incidence rates of breast cancer by age [10].

Age specific mortality data at the national level: The age and sex specific general mortality distribution for the year 2007 for urban areas of India based on the SRS (Sample Registration Scheme) estimates was obtained from National Health Profile 2010 which was utilized for getting the all causes mortality [8].

Estimation of probabilities in Competing Risk Approach (CRA): competing risk approach three types of probability is estimated employing the life table methodology viz: (i) the probability of death from specific cause in the presence of all other risk factors acting in a population, known as the crude probability (a); (ii) the probability of death if a specific risk is eliminated from the population known as net probability (a-c); (iii) the probability of death from a specific cause when another risk (or risks) is eliminated from the population known as partial crude probability {a-(b-c)} [11]. In the above definitions usage of the terms 'risk' and cause refers to the position of time relative to the occurrence of death (prior to death as risk and after death the same condition may form as a 'cause').

Competing Risk Approach Assumptions: The computations were based on the following assumptions: (i) The age specific pooled cancer incidence and mortality estimated based on 6 PBCRs is assumed to represent the national level rates; (ii) In the absence of general mortality rates relating to these 6 urban PBCRs national level mortality rates were considered.

Estimation of loss of life using Life table method: The study of the relationship of crude probability with the net and partial crude probability is known as multiple decrement procedure which was employed in competing risk approach. A life table approach for an initially disease-free cohort over time has been employed with the risk of breast cancer incidence, mortality and the competing risk of all other diseases as represented by general mortality.

Estimation of Total Person Years Lived (TPYL): TPYL by different cohorts of population was computed after allowing different attrition rates. Taking the differences in TPYL in different life tables, YLD and YLL were derived [12].

Estimation of Loss in Expectation of Life (LEL): To estimate the loss in expectation of life, three life tables were constructed: (i) a general life table employing the risk of mortality rate due to all causes ('a'); (ii) life table using differences in the risk of mortality due to all causes and risk of death from breast cancer ('a-c') and; (iii) risk of death from all causes other than breast cancer {'a-(b-c)'}. From the above life tables the differences in the above expectation of life viz (i)-(ii), (i)-(iii) and (ii)-(iii) represented the various expectation of life in presence of all the causes of death, and the expectation of life in the assumed absence of death due to breast cancer and also in the absence of development of breast cancer.

All the above computations for the present paper were undertaken during the months of October-February 2014 in the Department of Community Medicine of a Medical College. All the computations were carried out using Microsoft Excel 97 (v8.0).

RESULTS

It was noted that incidence of breast cancer increased with increasing age. The incidence was found to rise from 30 years of age onwards (14.11 per 100,000 females) till 64 years. However, the incidence rates were highest in 70+ year's age group. The general mortality rate increased with increasing age after the age of 5 years. Death rate due to breast cancer increased with age revealing highest mortality in persons 70 years and above [Table/Fig-1].

The competing risk approach methodology through life table in a cohort of 100,000 population from 0 -70+ years revealed the DALYs as 40209 per 100,000 females in the life time of 0-70 years [Table/Fig-2a]. Using CRA considering the risk of death from all causes the expectation of life was estimated to be 80 years. When risk of incidence and that of death from other causes were considered expectation of life was estimated to be 79.71 years and it was 80.11 years after excluding breast cancer mortality with a loss of expectation of 0.11 years [Table/Fig-2a]. Percentage of YLL to DALYs was found to be 28.20% in the cohort which increased with increasing age [Table/Fig-2b].

Age group (yrs)	Breast cancer incidence per 100000**	General Mortality rate per 1000	Breast cancer mortality rate per 100000**
00-04	0.0500	9.6	0.0000
05-09	0.0000	0.7	0.0222
10-14	0.0394	0.6	0.0000
15-19	0.2887	1	0.0000
20-24	2.0999	1.5	0.1585
25-29	6.5706	1.7	0.8287
30-34	14.1116	2	1.7964
35-39	27.4713	2.8	3.5674
40-44	49.8271	3.8	7.4462
45-49	71.0842	5.2	12.6154
50-54	96.6318	7.7	20.6957
55-59	111.9485	11.9	23.3912
60-64	115.4988	20	23.2879
65-69	100.3603	30.2	23.6476
70+	162.7500	76.9	54.6500

[Table/Fig-1]: Age specific general mortality rate for urban area of India (per 1000)* Pooled cancer incidence and mortality rate for breast cancer by age groups (per 100,000)
* Source: National Health Profile 2010, Mortality rate for urban 2007
**Pooled incidence and mortality rate breast cancer 2006-2008

Column no.	Attrition Item	Total person years (Tx)	Expectation of life (Ex)
1	General mortality (a)	8000259.3	80.00
2	{general mortality (a) - incidence of breast cancer (b) - Mortality due to breast cancer (c)}	7971392.3	79.71
3	{general mortality (a)- breast cancer mortality (c)}	8011601.6	80.11
4	YLD = Tx of Column1 - Tx of Column 2	28867.0	
5	YLL = Tx of Column 3 - Tx of Column 1	11342.2	
6	DALYs = YLL+YLD	40209.2	
7	Loss of expectation of life (LEL) due to breast cancer (Ex) Column 3-(Ex) of Column 1		0.11 years

[Table/Fig-2a]: Total person years and expectation of life according to various causes of attrition in a cohort of 100,000 persons from 0 – 70+ years based on life table approach

DISCUSSION

Competing risk is employed in several situations such as nephrology and cardiovascular diseases where several factors are competing with the event of death [13,14]. This approach allows for the analysis of time to first observed event as well as for type of first event. Generally competing risk approach is most relevant if the time to a specific event is of primary interest. However, the other competing events may preclude its occurrence or greatly alter the chances to

Age group (yrs)	Years lived with disability (YLD)	Years of life lost (YLL)	Total DALYs	% of YLL to DALYs
00-04	28867	11342	40209	28.20
05-09	28867	11342	40209	28.20
10-14	28867	11342	40209	28.20
15-19	28866	11342	40209	28.20
20-24	28865	11342	40207	28.20
25-29	28859	11341	40200	28.21
30-34	28833	11339	40172	28.22
35-39	28764	11329	40093	28.25
40-44	28605	11307	39912	28.32
45-49	28285	11257	39543	28.46
50-54	27722	11159	38881	28.70
55-59	26837	10982	37819	29.03
60-64	25569	10700	36269	29.50
65-69	23896	10313	34209	30.14
70+	21879	9827	31706	30.99

[Table/Fig-2b]: Total Years of life lost per 100000 populations using competing risk approach

observe it. Competing risk approach is similar to the studies dealing with loss or gain from a particular disease. This is relatively a simpler approach which originates from the fact that death is an unavoidable event for anyone. The theory impacts on elimination of a particular cause on the population [7,12].

DALY is a summary measure that can reflect the burden of both morbidity and mortality in a single indicator which was introduced during the analysis of data on Global Burden of Disease (GBD). The analysis of data was carried out employing DISMOD (DISease MODeling) procedure [15]. However, the method of computation of DALY through DISMOD2 approach in a disease like cancer is complex and it requires enormous data in terms of incidence, prevalence, and duration of disease, case-fatality and remission rates of each site of cancer in different age-sex groups separately for each level of severity of the cancer [16]. Many developing countries do not generate data with all these parameters.

The requirement of data for competing risk method is minimal in terms of: (i) age and sex wise general mortality due to all causes in the population; (ii) age, sex and site specific incidence; & (iii) mortality due to the disease under investigation. Making use of these data YLL, YLD and DALYs can be easily computed. Further, loss or gain in terms of expectation life can be easily computed through abridged life table. In the present study it has been estimated that DALYS for breast cancer in India during 2006- 08 was estimated to be 40209 per 100,000 females in the life time of 0-70 years with a loss of expectation of 0.11 years. Percentage of YLL to DALYs was found to be 28.20% in the cohort which indicates that women after the development of breast cancer with appropriate treatment modality are likely to survive for a longer period. The findings of the study revealed that most of the loss has been observed in the productive years of life between 30-60 years. This loss of life due to breast cancer not only causes a great burden to the family but even to the society at large. There is a steep increase in the incidence and mortality of breast cancer in the middle age group.

The DALY's estimate reported for the year 2006 based on female population of the country using DISMOD2 by Murthy et al., revealed a loss which amounts to 0.17 years per person (female) with breast cancer. Further that is also been reported that the percentage of YLL to DALYs was 38.14%. The present findings are somewhat similar to this study [17]. However, it may not be appropriate to compare the two approaches directly in view of different computational methodologies and weightings adopted. In the DISMOD2 approach for calculation of DALY's, the disability weightings considered based WHO global burden of disease study with certain assumptions. The computations relates to the population at that point of time. For developing countries where there is a dearth of data for estimating burden, CRA can be used as it is a simpler method which requires less and easier computation. It can be considered as another useful summary measure of the burden of cancer in a population as it estimates the probability of developing or dying due to cancer, either over a lifetime or over a specified number of years. Probabilities of developing or dying due to cancer can be estimated after removing the risk due to other causes. Using competing risk models, the probabilities of death due to various risks can be separated. Several approaches are available for estimating these probabilities with and without considering the effect of competing risk.

Competing risk scenario arises when death is attributed to several risks unambiguously. As indicated earlier in this article the net and the partial crude probability of death due to cancer cannot be estimated directly but can be attempted through the relationship of crude probability. Competing risk has got an additional advantage of providing loss or gain in expectation of life unlike the overall figure in DALY derived through DISMOD approach. The loss of expectation of life of 0.11 years observed in the present study reveals the urgent need for initiating control and prevention of breast cancer. Most of the loss which appeared after 35 years of age puts a major burden on the society. It has been shown that both primary prevention methods like breast feeding and secondary prevention methods such as breast self examination and clinical examination of breast have been found to be most effective in control and prevention of breast cancer [18,19]. Every woman in the cohort experienced the loss of expectation of life of 0.11 years and majority of them took place in the most productive age group. These types of computations will help to identify the burden of such diseases using minimal information.

CONCLUSION

The present study estimated DALYs using competing risk approach as 40209 per 100,000 females in the life time of 0-70+ years with a loss of expectation of 0.11 years. Most of the loss has been observed in the productive years of life between 30-60 years. This type of computation will help identify the burden of such diseases using minimal information in terms of loss or gain of expectation life. It can be easily computed and employs a simpler approach compared to DISMOD2.

REFERENCES

[1] GLOBOCAN 2012: Estimated cancer incidence, mortality and prevalence worldwide 2012. Available from: http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx (accessed 10 January 2014).
[2] Latest world cancer statistics. http://www.iarc.fr/en/media-centre/pr/2013/pdfs/pr223_E.pdf (accessed 6 December 2014).
[3] Indian Council of Medical Research. Three year report of population based cancer registries 2009-2011. Indian Council of Medical Research. 2013.
[4] Dhillon PK. Breast cancer fact sheet. Available from: http://www.sancd.org/Breast%20cancer%20factsheet%2003.11.11.pdf (accessed 8 March 2014).
[5] Yeole BB. Role of the Cancer Registries in Determining Cancer Mortality. *Asian Pacific J Cancer Prev*. 2006;7:489-91.
[6] World Development report. New York: Oxford press; 1993.
[7] Dhar M, Lahiri S, Vijayasimha R, Ashok NC, Murthy NS. Study of social loss or gain from a particular cause: Scope for the developing countries- A review with reference to cancer. *Asian Pacific Journal for Cancer prevention*. 2008;9:797-804.
[8] National Health Profile 2010. New Delhi: Central Bureau of Health Intelligence; 2011.
[9] Indian Council of Medical Research. Three year report of population based cancer registries 2006-2008. Indian Council of Medical Research. 2010.
[10] National Cancer Registry Programme. Report of the population based registries 2001- 2004, incidence and distribution of cancer. Indian Council of Medical Research. 2006. From http://cbhidghs.nic.in/writereaddata/mainlinkFile/File-1012.pdf (accessed 6 December 2014).
[11] Ching long Chiang. World health organization: Life table and mortality analysis. Available from: http://apps.who.int/iris/bitstream/10665/62916/1/15736_eng.pdf?ua=1 (accessed on 8 March 2014).
[12] Dhar M, Lahiri S, Takiar R, Ashok NC, Murthy NS. An indirect study of cancer survival in the context of developing countries. *Asian Pacific Journal for cancer prevention*. 2008;9:479-86.

[13] Wolbers M, Koller MT, Stel VS, Schaer B, Jager KJ, Leffondré K, et al. Competing risks analyses: objectives and approaches. *Eur Heart J*. 2014;35(42):2936-41.
[14] Noordzij M, Leffondré K, van Stralen KJ, Zoccali C, Dekker FW, Jager KJ. When do we need competing risks methods for survival analysis in nephrology? *Nephrol Dial Transplant*. 2013;28(11):2670-77.
[15] Murray CJL, Lopez AD, editors. The Global Burden of Disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2030).
[16] National burden of disease study a practical guide. Global program on evidence for health policy World health organization; Oct 2001, edition 2.0.
[17] Murthy NS, Nandakumar BS, Pruthvish S, George PS, Mathew A. Disability Adjusted Life Years for Cancer Patients in India. *Asian Pacific Journal of Cancer Prevention*. 2010;11(3):633-40.
[18] Murthy NS, Mathew A. Cancer epidemiology, prevention and control. *Current Science*. 2004;86(4):518-37.
[19] Aleyamma M, Rajan B. Epidemiology of Cancer and Prevention of Cancer in India, 1/e ed: Jaypee Brothers Pvt Ltd; 2005.

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