Estimating the Burden of Cancer

Projections of the incidence of cancer serve several purposes. These range from making investment decisions on cancer treatment facilities and planning manpower requirements, to formulation and evaluation of policies for control of cancer.

Different statistical methods can be used for such projections. In recent years, these have been translated to user-friendly software application modules. The methods include the simple linear regression method (LR),[1] the join point regression method (JP),[2] and the age, period and cohort model (APC).[3] The first two methods can be used with or without taking age as a factor. When age is not taken into account, the crude incidence rate (CR) is used. For all these methods, the primary requirement is reliable data on incidence for various cancers for at least a sample of the population. A well run population-based cancer registry provides valid incidence and mortality rates for the defined populations that they cater to. Since 1982, the National Cancer Registry Programme (NCRP) of the Indian Council of Medical Research has been collecting such information through its population-based cancer registries which now number 27. Though these registries cover only 7% of the population of India, they do provide a fair idea of the magnitude and patterns of cancer, which allows reasonable extrapolation of the burden of cancer for the rest of the country. The publication of the report on 'Time trends in cancer incidence rates: 1982–2005'[4] further strengthened the accuracy of such estimates on the burden of cancer.

The APC modelling for projection takes care of non-linear trends in the data including the possible contribution of period and cohort to the trend. However, one needs to show whether the latter two actually have an effect so as to alter the predictions in a major way, especially in the Indian context. The Surveillance, Epidemiology, End Results Program (SEER) in the USA uses the JP regression method to study changes in time trends and to provide estimates of various cancers.

We predicted cancer cases by all the above methods—LR with CR, LR with effect of age, JP with CR, JP with effect of age and APC modelling—using the incidence data of Bengaluru (for 1982–2001) and Delhi (for 1988–2002) to project the burden of cancer for 2006–07. We then compared the projections by different methods with the actual data reported for 2006–07.[5] The difference in the numbers obtained by different methods was also examined keeping the APC model as the base (Table I).

The estimated number of cases for both Bengaluru and Delhi, using the population-based cancer registry data with all 5 methods including APC modelling, were lower

TABLE I. Estimated number of cases (≥25 years) for specific sites by 5 different methods for Bangalore* and Delhi† (2006–07)

Method		City	Site of cancer						
			Men			Women			
			All sites	Prostate	Colon	All sites	Breast	Cervix	Ovary
LR	CR	Bangalore	4430	251	142	5374	1377	**703**	307
		Delhi	**12 265**	806	315	**11 066**	3211	**1382**	920
	Age	Bangalore	**3997**	256	149	5172	1389	**684**	290
		Delhi	**11 959**	819	267	**10 992**	3084	**1336**	898
JP	CR	Bangalore	**3713**	254	122	5129	1422	786	**249**
		Delhi	**11 594**	831	321	**11 119**	3220	1534	822
	Age	Bangalore	**4073**	235	127	4932	1450	822	382
		Delhi	**11 418**	667	268	**10 887**	**3256**	1519	866
Age period cohort (APC)		Bangalore	4362	243	112	5213	1432	849	338
		Delhi	10 540	747	292	10 464	2997	1661	867
Based on NCRP Report		Bangalore	5349	372	216	6760	1867	1066	380
		Delhi	12 318	959	295	11 905	3370	1826	896

* based on population-based cancer registry data of 1982–2001 † based on population-based cancer registry data of 1988–2002 LR linear regression JP join point CR crude rate NCRP National Cancer Registry Programme Values that are significantly ($p<0.05$) lower than that derived through the APC model are shown in bold while those significantly higher are underlined

than the actual reported data. This was almost uniform among men and women except for all-sites among women using the JP and CR method and ovarian cancer using the LR and CR as well as LR and age method for Delhi where the numbers were slightly higher than those for the APC modelling estimates. The prediction for both Bengaluru and Delhi using the LR and CR method were comparable to those observed with the APC method, again with some exceptions such as for cancer of the cervix where it was significantly lower and for all-sites in men and women in Delhi where it was significantly higher. Thus, the different methods gave different estimates though most methods erred in providing lower estimates.

It is essential to adopt a systematic scientific and statistical approach to estimating prediction of number of cancer cases for various anatomical sites of cancer, especially in a developing country such as India. The paucity of data from the rural areas other than the northeast region makes this task even more difficult. The article by Swaminathan *et al*.[6] in this issue provides one standard method to estimate the burden of cancer in Tamil Nadu based on data from Chennai city and Dindigul district (a predominantly rural district). Using a combination of the data, the paper provides estimates using APC modelling for the state of Tamil Nadu. The authors acknowledge that their estimates could err on either side—more or less than the actual numbers. Nonetheless, the availability of these estimates would be useful for policy-makers and planners.

Since the commencement of the NCRP in 1982, annual, bi-annual and consolidated reports have been regularly published. A brief report on time trends in incidence rates was presented in the consolidated report for 1990–96.[7] The first systematic report on trends in incidence rates over 2 decades[4] shows a steady and consistent increase in the age-adjusted incidence rates of certain cancers across all major urban registries. Among men, cancers of the prostate, colon, rectum and liver have shown statistically significant increase in incidence. Cancer of the prostate is the leading site of cancer among men in most western countries as is cancer of the colon. Among women, cancers of the breast, corpus uteri and lung have shown a rise. While the first two of these cancers could be accounted for because of cohorts with later age at marriage, decreasing multi-parity and so on, the increase in lung cancer could be attributed to an increase in the use of tobacco by women. Lung cancer in women may also be increasing because of environmental exposure to smoke (passive smoking). Three other sites of cancer that have shown an increase in incidence rates in women are ovary, thyroid and gallbladder. The increase in gallbladder cancer is seen in registries that have recorded a comparatively lower incidence than Delhi, which showed an increasing trend only during the earlier years, with a decline in more recent years. There have been rising incidence rates for cancers of the brain as well as in tumours of the lymphoid and haemopoetic system, especially non-Hodgkin lymphoma in both men and women. The decline in the incidence of cancer cervix is seen across all registries including the rural registry at Barshi. This decline is observed in the absence of any organized screening or early detection programmes in the registry areas. The factors contributing to an increase in breast cancer could possibly be responsible for the decline in the incidence of cancer of the cervix. Another possible reason for the decline could be an increase in the number of child-births at institutions (as opposed to home deliveries) leading to improved maternal and maternity care including genital hygiene. This could be a result of the family welfare drive initiated by the government about 4 decades ago and which is continuing. Better genital hygiene, barrier contraceptive use and superior nourishment could all have contributed to the reducing incidence of cancer of the cervix.

The NCRP data that have accrued over the years are essentially that of selected urban centres and only one rural registry that covers part of a district is represented. Therefore, it would be difficult to provide valid estimates of the burden of cancer for the entire country with over 70% of the population of India residing in rural areas. Nonetheless, limited exercises have been done and the paper by Swaminathan *et al*. is another step towards obtaining more projections of cancer in India. Table II provides a summary of estimated new cancers from the first systematic report on trends in incidence rates over 2 decades for India.[4]

TABLE II. Estimated new cancers at all anatomical sites (ICD-10: C00–C96)

Year	Men	Women	Total
2008	447 399	498 773	946 172
2009	454 842	507 990	962 832
2010	462 408	517 378	979 787
2015	497 081	563 808	1 060 889
2020	534 354	614 404	1 148 758

REFERENCES

1 Boyle P, Parkin DM. Cancer registration: Principles and methods. Statistical methods for registries. *IARC Sci Publ* 1991;**95:**126–58.
2 Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for join point regression with applications to cancer rates. *Stat Med* 2000;**19:**335–51. Erratum in *Stat Med* 2001;**20:**655.
3 Parkin DM, Muir CS, Whelan SL, Gao YT, FerlayJ, Powell JJ (eds). *Cancer incidence in five continents, Vol. VI.* Lyon, France:IARC Sci Publ No. 120; 1992.
4 National Cancer Registry Programme (NCRP, ICMR). *Time trends in cancer incidence rates (1982–2005).* Bengaluru:NCRP-ICMR; 2009.
5 National Cancer Registry Programme (NCRP, ICMR). *Three-year report of population based cancer registries (2006–8).* Bengaluru:NCRP-ICMR; 2010.
6 Swaminathan R, Shanta V, Ferlay J, Balasubramanian S, Bray F, Sankaranaryanan R. Trends in cancer incidence in Chennai city (1982–2006) and statewide predictions of future burden in Tamil Nadu (2007–16). *Natl Med J India* 2011;**24:**72–7.
7 National Cancer Registry Programme (NCRP, ICMR). *Consolidated report of the population based cancer registries (1990–1996).* Bengaluru:NCRP-ICMR; 2001.

T. RAMNATH
A. NANDAKUMAR
Coordinating Unit
National Cancer Registry Programme (ICMR)
Nirmal Bhawan, ICMR Complex
Kannamangala Post
Bengaluru
Karnataka
ank@blr.vsnl.net.in, ncrpblr@canceratlasindia.org