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STUDY OF THE CANCER PATTERN IN MAHARASHTRA

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Abstract

In this study, the data regarding the cancer patients in the four major cancer registries of Maharashtra State have been collected, during the years 2006, 2007 and 2008. The objectives of the study were to observe the distribution of cancer in the population; to find out the cancer sites mostly observed among the children, that is, childhood cancer; to measure the cancer incidence rate for the years 2006 to 2008 for the four major registries in Maharashtra, to compare the incidence rates in the registries, to measure the risk of cancer at various age-groups, to carry out rural-urban comparison for cancer incidence rates, to measure the cancer mortality rate for the years 2006 to 2008 for the four major registries in Maharashtra.

Keywords*: cancer surveillance, cancer registry, incidence rate, age-specific rate, age-standardization*

1. INTRODUCTION

1.1 Cancer Surveillance

Cancer surveillance is essential to a unified, scientific and public health approach to cancer prevention and control. Cancer surveillance is the ongoing, timely, and systematic collection and analysis of information on cancer risk factors (such as lifestyle factors, behavioral influences, genetic predispositions, or environmental exposures), screening and early detection, new cancer cases, cancer deaths, extent of disease at diagnosis, treatment, clinical management, and survival. Key to the success of cancer prevention and control is the timely dissemination of cancer data to the public health agencies and scientists responsible for designing, implementing, and evaluating cancer prevention and control activities. The role of surveillance in providing critical feedback to public health programs has been well recognized. It is an ongoing system of data collection and collation.

This is done by several methods such as:

(a) Cohort studies wherein a cohort, that is, a group of people under certain inclusion criteria are followed & observed for a defined period of time and thus a new case or event of interest is recorded.

(b) Cross-sectional studies wherein the exposure status and outcome status at a single point in time, or over a short period in the life of members of a sample population are simultaneously observed.

(c) National Family Health Survey (NFHS) in which the data is collected on several diseases, and can be used as inputs for some of the variables related to cancer studies.

(d) The most widely used method is through registry data. The registry covers the entire population and along with other surveys such as population census, makes available all the data required for cancer surveillance.

1.2 Cancer Registry

McLennan et al (1978) has defined cancer registration as a process of continuing systematic collection of data on the occurrence and characteristics of reportable neoplasm.

Broadly there are two types of cancer registries. One is the Population Based and the other is a Hospital Based Cancer Registry, abbreviated as PBCR and HBCR, respectively. Registries could also be developed for a special purpose in relation to specific exposures, or, they could also be established for a specific anatomical site like Bone Tumor and Lymphoma registries. Registries could also specifically cater to a particular age group as for children or for the elderly.

The basic thrust of a PBCR is cancer in the community. PBCRs provide information on cancer incidence and mortality in a defined population and for a particular time period. They also provide information on variation in incidence or mortality over time and with follow up, population based cancer survival rates.

Generally, there are several sources of registration for a PBCR from where staff of registries collects information on cancer cases. These include pathology reports, medical records, radiology and radiotherapy departments and death certificates. The availability of up-dated investigation or diagnostic facilities, well maintained medical records using International Classification of Diseases together with an efficient death registration system are essential for completeness as well as good quality cancer registration.

Cancer is not yet a reportable disease in India. Therefore, methodology of data collection by the PBCRs is active, in which, registry staffs make visits to various sources of registration to collect information on cancers recorded in the respective institutions. The advent of

computing technology is gradually changing the method of working of cancer registries in India.

Studying the magnitude and patterns of cancer helps in determining clues to the cause of cancer and undertake studies in preventing the disease. Cancer registries provide the needed information to undertake such investigations. The PBCRs constitute a base for carrying out scientific investigations in cancer etiology. The population based design provides considerable strength and makes the results of both case control and cohort studies, extremely valid.

Cancer registration is a means to a purpose and not a purpose in itself. It is necessary in all settings, more so in the setting of a developing country like India. The National Cancer Registry Programme (NCRP) was established under the Indian Council of Medical Research (ICMR) in 1981 with the definitive aim of assessing incidence and distribution of cancer in the Country.

1.3 History

In India, three HBCR and three PBCR commenced data collection on 01 Jan 1982. Over the years, the registry network expanded so as to have 23 PBCRs under the NCRP network. These also included registries developed for examining special exposures like Bhopal PBCR. This was a significant attempt to register as many cases as possible in their respective geographic area. The WHO project on "Development of an Atlas of Cancer in India" provided some hitherto unknown information on the incidence and patterns of cancer in the North East. Based on the leads obtained, the ICMR commenced PBCRs in four of the eight North Eastern states in 2003, and from January 2009 in three additional states of the North East. The advent and optimal use of information technology in capturing and transmitting information, has eased the effort and reduced the time taken in processing while also significantly improving the quality of data. The Coordinating Unit has paid a special emphasis on the quality of data along with its completeness and validity. Various quality checks are carried out on the data in keeping with the international data quality indices.

Under the National Cancer Registry Programme (NCRP), the Indian Council of Medical Research commenced a network of cancer registries across the country in December 1981 with the objectives of:

1. Generating reliable data on the magnitude and patterns of cancer - this would be based on morbidity and mortality information in different regions of the country according to sex, age and residence of the patient, anatomical site of cancer and proportion of histological

type or microscopic confirmation for each site; pattern of different types of cancer according to relative proportions or ratios in various population sub-groups such as religion, language spoken, educational status; clinical stage of disease when patients come to hospital for treatment and where possible the nature of treatment received and outcome;

2. Undertaking epidemiologic research, such as case control or cohort studies based on observations of registry data;
3. Providing data base for developing appropriate strategies to aid in National Cancer Control Programme; this would be in the form of planning, monitoring and evaluation of activities under this Programme;
4. Develop training programmes in cancer registration and epidemiology.

Coding of the disease is done according to International Classification of Diseases (WHO, ICD-10). This facilitates comparison of our data with that from registries across the world. In addition, to facilitate the detailed histologic studies, coding is also done according to International Classification of Disease for Oncology (WHO, 3rd Edition 2002). The hospitals include the main cancer hospitals, other general hospitals in both the government and private sector. Also pathology laboratories that routinely report cancer cases are also visited. Death certificates are also scrutinized from the municipal corporation units. Every attempt is made by registries to register all cancer patients in the registration area who are resident (at least one year) in the same area, from all hospitals and from all death certificates in which cancer is mentioned.

Certain basic checks of data, especially those related to duplicate verification and matching with mortality records, are carried out by the individual registries. After this, the data is sent to the Coordinating Unit for subjecting the data to various range, consistency checks and unlikely combinations including a further round of possible duplicate listing. The lists of cases with the items of patient information, which require verification, are sent to the respective registries by the Coordinating Unit. Individual registries go through the records/reports of such cases and wherever necessary discuss with the concerned clinician or the pathologist. On receiving the clarifications the Coordinating Unit prepares the detailed tabulations by five-year age group, site and sex, including rates. The individual registries use these tables to prepare the registry's annual report. The Coordinating Unit collates the data and performs tabulations to prepare the consolidated report of that year.

Apart from the above, the Coordinating Unit undertakes and coordinates epidemiologic and other research studies, including those to ensure that the quality of data is of a high standard and that coverage of cancer cases in the registry area is as complete as possible. Over the years, staff from registries under the NCRP, have benefited from both short and long term training fellowships in established institutions abroad. This has helped them and the registries to develop into departments of epidemiology and undertake several studies on their own and contribute to several research publications in indexed journals.

1.4 Registries in Maharashtra

Population Based Rural Cancer Registry, Barshi ((Barshi, Paranda & Bhum)

Nargis Dutt Memorial Cancer Hospital, Barshi

The Rural Cancer Registry: Barshi, Paranda and Bhum which was set up in 1987, is the first Rural Cancer Registry in the country and is situated in the campus of Nargis Dutt Memorial Cancer Hospital (NDMCH) located on the outskirts of Barshi town. The registry is jointly funded by the Tata Memorial Centre, Mumbai and the Indian Council of Medical Research, New Delhi. The diagnostic and treatment facilities are provided by NDMCH with technological support from Tata Memorial Hospital.

Population Based Cancer Registry, Mumbai

Indian Cancer Society, Mumbai

The Mumbai Cancer Registry was established in June 1963 as a unit of the Indian Cancer Society at Mumbai, with the aim of obtaining reliable morbidity and mortality data on cancer from a precisely defined urban population (Greater Mumbai).

Registry publishes yearly reports regularly. The registry has published more than 100 articles in indexed journals and 40 monographs on cancer incidence and mortality. The registry data is also used by public health workers for epidemiologic studies, by government for cancer controls programme, by journalists for public education and by medical companies for promotion of their product. Registry records follow-up information for major primary sites for the registered 1982 onwards

Population Based Cancer Registry, Aurangabad

The Aurangabad Cancer Registry is a division of Indian Cancer Society and it became operative on 1st January 1980, with the collaborative effort with Aurangabad Medical College and hospital. The registry was started with aim of obtaining reliable incidence & mortality data for the population of Aurangabad City Agglomeration.

Population Based Cancer Registry, Pune

The Pune Cancer Registry**,** a satellite registry of the Mumbai Cancer Registry commenced its operation on 1st March, 1972 as a collaborative effort with the B.J. Medical College and Sasson Hospital at Pune, with the aim of obtaining reliable incidence and mortality data on cancer in Pune City Agglomeration.

2. SOURCE OF DATA

The data was made available from the PBCR, Mumbai. The registry provided the data for the years 2006, 2007, 2008 for the Barshi, Mumbai, Aurangabad and Pune. The operation method however varies for rural and urban registries.

Method of Registration for the rural registry

Barshi: The usual method of registration was modified to overcome deficiencies in diagnostic services in the rural setting. Trained field investigators visit the villages regularly and interact with the rural community to identify and motivate likely cancer cases to visit NDMCH for early diagnosis and treatment. To screen symptomatic cases, cancer detection clinics are held bi-annually in each of the 12 zones, into which the registry area is divided. Data on cancer cases from the area are also collected from various hospitals and his topathological laboratories (situated far and wide) which serve the population. However 60% of cases are registered from NDMCH to which the field investigators generally refer the suspected cases.

Method of Registration for the urban registry:

Mumbai: Information is obtained on all cancer patients diagnosed in 150 government hospitals institutions and private hospitals nursing homes in Mumbai, which are under the care of specialists, that is, surgeons, physicians, pathologists, radiologists and gynecologists. The major source of the data is the Tata Memorial Centre, which is a postgraduate teaching hospital. General medical practitioners are not contacted individually as, according to local practice, only specialist assume charge of cancer patients in private hospitals and nursing homes and very few patients who are not admitted for hospital care are at some stage referred to specialists.

Staff of registry visits the wards of all collaborating hospitals, at least once a week, to interview each cancer patients as well as those suspected having cancer. All files maintained by various departments of these hospitals are also checked. Care is taken to prevent duplication of an entry relating to a patient already registered. Supplementary information is gleaned from the death records maintained by the Municipal Corporation. This makes it

possible to check on missed cases. Every cancer death not traceable to an entry in the files is labeled as unmatched death and is so registered for the corresponding year. Registry collects information on multiple cancers as per the guidelines and definition provided by the International Association of Cancer Registries.

Aurangabad: Information is obtained on all cancer patients registered at 3 major hospitals and 6 nursing homes. The death records maintained by Municipal Corporation provide a means of checking on missed cases.

Pune: There are 16 major hospitals in Pune City and 6 major hospitals in Mumbai that contribute to this registry. The death records maintained by the Pune Municipal Corporation provide means for checking on missed cases. Staff of the registry visits the cancer patient wards and department of Medical Records at least once a week to collect the information on cancer patients.

The population of each registry was obtained for the years 2006-2008. Each registry gives the population measured as mid-year population. These figures are then used to calculate the incidence rate. For the purpose of the analysis, the population considered was of the year 2007 as mid-term population.

Table 1: Age-group wise Male population for the year 2007

Registry	0-14	15-29	30-54	55-74	Total
Barshi	277911	214131	214686	110094	816822
Mumbai	5216778	7712346	7448334	1801125	22178583
Aurangabad	616104	524169	522300	112614	1775187
Pune	1964598	2406084	2351214	574737	7296633

Table 2: Age-group wise Female population for the year 2007

Registry	0-14	15-29	30-54	55-74	Total
Barshi	245295	172131	200412	131190	749028
Mumbai	4644261	5321184	6026601	1747023	17739069
Aurangabad	533514	498582	442590	138207	1612893
Pune	1765926	2050875	2121534	595011	6533346

The incident cases & mortality data was available for each cancer site and age-group of 4 years (0-4, 5-9, ..., 65-69, 70-74). The data has been rearranged to reduce the number of age-groups as pediatric (0-14 yrs), young (15-29 yrs), adult (30-54 yrs), and geriatric (55-74 yrs). The age group of 75+ is not considered as very few cases in this age-group are registered. Also various cancer types were classified into groups according to the International Classification of Diseases- Tenth revision) **(ICD-10)** for coding the primary site.

Data table was prepared for each registry by summing up the number of incident cases for the years 2006, 2007 and 2008, for males and females separately.

Table 3: Number of incident cancer cases by site groups and age-groups, 2006-2008, Males

Site Code ICD-10	Site Name	Name of the Registry	Age-groups 0-14	15-29	30-54	55-74	Total
C0-14	lip, oral cavity & pharynx	Barshi	1	2	16	30	49
		Mumbai	11	93	1363	1346	2813
		Aurangabad	1	9	71	63	144
		Pune	4	16	297	367	684
C15-26	digestive organs	Barshi	2	1	24	64	91
		Mumbai	18	72	1114	2130	3334
		Aurangabad	0	9	41	77	127
		Pune	0	21	280	574	875
C30-39	respiratory systems	Barshi	0	1	10	24	35
		Mumbai	5	23	579	1302	1909
		Aurangabad	0	5	40	87	132
		Pune	1	7	150	317	475
C60-68	urinary + genital	Barshi	2	0	11	32	45
		Mumbai	27	64	377	1125	1593
		Aurangabad	3	3	21	36	63
		Pune	6	15	92	320	433
C81-90	lymphatic systems	Barshi	5	7	7	3	22
		Mumbai	68	93	384	467	1012
		Aurangabad	4	10	21	12	47
		Pune	20	17	89	120	246
C91-95	Leukemia	Barshi	10	5	6	4	25
		Mumbai	207	137	230	164	738
		Aurangabad	8	9	12	15	44
		Pune	30	28	44	39	141
	All sites combined	Barshi	25	26	91	191	333
		Mumbai	495	727	4886	7360	13468
		Aurangabad	23	61	250	335	669
		Pune	102	182	1168	1951	3403

From table 3, it can be seen that, among males, for all sites, the cancer incidence cases are increasing with age, except for leukemia which has quite high number of incidence cases in the younger age groups.

Table 4: Number of incident cancer cases by site groups and age-groups, 2006-2008, Females

Site Code ICD-10	Site Name	Name of the Registry	Age-groups 0-14	15-29	30-54	55-74	Total
C0-14	lip, oral cavity & pharynx	Barshi	0	1	1	10	12
		Mumbai	20	32	468	485	1005
		Aurangabad	2	2	34	25	63
		Pune	2	6	152	194	354
C15-26	digestive organs	Barshi	0	2	17	35	54
		Mumbai	11	77	901	1278	2267
		Aurangabad	0	1	43	45	89
		Pune	2	24	190	333	549
C30-39	respiratory systems	Barshi	0	0	8	14	22
		Mumbai	5	15	232	388	640
		Aurangabad	0	4	12	26	42
		Pune	0	5	77	119	201
C50	breast	Barshi	0	0	30	26	56
		Mumbai	4	275	2733	1941	4953
		Aurangabad	0	2	113	76	191
		Pune	3	21	626	557	1207
C53	cervix uteri	Barshi	0	0	48	60	108
		Mumbai	0	28	1280	849	2157
		Aurangabad	0	2	81	67	150
		Pune	0	13	338	280	631
C51-58	other female genital	Barshi	0	2	17	26	45
		Mumbai	16	95	789	894	1794
		Aurangabad	0	7	25	26	58
		Pune	4	19	170	233	426
C64-68	urinary organs	Barshi	0	0	0	0	0
		Mumbai	7	10	88	153	258
		Aurangabad	1	1	5	6	13
		Pune	2	7	19	37	65
C81-90	lymphatic systems	Barshi	2	2	2	6	12
		Mumbai	25	41	217	341	624
		Aurangabad	4	0	8	8	20
		Pune	4	13	44	80	141
C91-95	Leukemia	Barshi	3	1	6	5	15
		Mumbai	124	95	141	122	482
		Aurangabad	13	7	11	9	40
		Pune	20	13	37	32	102
	All sites combined	Barshi	9	12	151	207	379
		Mumbai	281	847	7417	7094	15639
		Aurangabad	24	32	367	311	734
		Pune	74	179	1824	2002	4079

From table 4, it can be seen that, among females, for all sites, the cancer incidence cases are increasing with age, except for leukemia which has quite high number of incidence cases in the younger age groups, as in the case of males.

3. DATA ANALYSIS

Population and Cancer Incidence

The major concern of population based cancer registries (PBCR) is to calculate cancer incidence rates, study the rates of individual cancers by comparing cancer incidence and patterns in other registries and in different subgroups of population in respective areas.

The population based cancer registration data can be used to describe the magnitude of cancer burden in the community, for etiological studies, monitoring and assessing the effectiveness of cancer control activities.

The incidence rate

Incidence expresses the number of new cases of cancer which occur in a defined population of disease-free individuals, and the incidence rate is the number of such events in a specified period of time. Thus

$$Incidence\ Rate = \frac{\text{Number of new cases of disease in a period of time}}{\text{Population at risk}}$$

This measure provides a direct estimate of the probability or risk of illness, and is of fundamental importance in epidemiological studies. Since incidence rates relate to a period of time, it is necessary to define the exact date of onset of a new case of disease. For the cancer registry this is the incidence date. Although this does not correspond to the actual time of onset of a cancer, other possibilities are less easy to define in a consistent manner-for example, the date of onset of symptoms, date of entry to hospital, or the date of treatment.

Crude (all-ages) and age-specific rates

Suppose that there are A age groups for which the number of cases and the corresponding person-years of risk can be assessed. Frequently, the number of groups is 18 (A= 18) and the categories used are 0-4, 5-9, 10-14, 15-19, ..., 80-84 and 85 and over (85+). However, variations of classification are often used, for example, by separating children aged less than one year **(0)** from those aged between 1 and 4 (1-4) or by curtailing age classification at 75, that is, having age classes up to 70-74 and 75+.

Let r_i be the number of cases which have occurred in the i^{th} age class. If all cases are of known age, then the total number of cases *R* can be written as

$$R = \sum_{i=1}^{A} r_i = r_1 + r_2 + \ldots + r_A$$

Similarly, denoting by n_i the person-years of observation in the i^{th} age class during the same period of time as cases were counted, the total person-years of observation *N* can be written as

$$N = \sum_{i=1}^{A} n_i = n_1 + n_2 + \ldots + n_A$$

The crude, all-ages rate per *1,00,000* can be easily calculated by dividing the total number of cases *(R)* by the total number of person-years of observation *(N)* and multiplying the result by *1,00,000.*

$$Crude\ Rate = C = \frac{R}{N} \text{ x } 1{,}00{,}000$$

that is, when all cases are of known age,

$$C = \frac{\sum_{i=1}^{A} r_i}{\sum_{i=1}^{A} n_i} \text{ x } 1{,}00{,}000$$

Table 5: Crude rates, Males, 2006-2008

Region as in ICD-10	C0-14	C15-26	C30-39	C60-68	C81-90	C91-95	all sites combined
BARSHI	6.00	11.14	4.28	5.51	2.69	3.06	40.77
MUMBAI	12.68	15.03	8.61	7.18	4.56	3.33	60.73
AURANGABAD	8.11	7.15	7.44	3.55	2.65	2.48	37.69
PUNE	9.37	11.99	6.51	5.93	3.37	1.93	46.64

From table 5, we can see that among males, the most common sites in all four registries, with respect to crude rate of incidence of cancer are lip, oral cavity & pharynx (C0-14) and digestive organs (C15-26).

Table 6: Crude rates, Females, 2006-2008

Region as in ICD-10	C0-14	C15-26	C30-39	C50	C53	C51-58	C64-68	C81-90	C91-95	All sites combined
BARSHI	1.60	7.21	2.94	7.48	14.42	6.01	0.00	1.60	2.00	50.60
MUMBAI	5.67	12.78	3.61	27.92	12.16	10.11	1.45	3.52	2.72	88.16

AURANG ABAD	3.91	5.52	2.60	11.84	9.30	3.60	0.81	1.24	2.48	45.51
PUNE	5.42	8.40	3.08	18.47	9.66	6.52	0.99	2.16	1.56	62.43

From table 6, we can see that among females, the most common sites in all four registries, with respect to crude rate of incidence of cancer are breast (C50) and cervix uteri (C53).

The age-specific rate for a particular age group, a_i, can also be simply calculated as a rate per 1,*00,000,* by dividing the number of cases in the age-class (r_i) by the corresponding person-years of observation (n_i) and multiplying the result by *100000.* Thus,

$$a_i = \frac{r_i}{n_i} \text{ x } 1{,}00{,}000$$

Age-standardization: direct method

An age-standardized rate is the theoretical rate which would have occurred if the observed age-specific rates applied in a reference population- this population is commonly referred to as the Standard Population. The populations in each age class of the Standard Population are known as the weights to be used in the standardization process. Many possible sets of weights, w_i**,** can be used. Use of different sets of weights (i.e., use of different standard populations) will produce different values for the standardized rate. The most frequently used is the World Standard Population**,** modified by Doll et al. (1966) from that proposed by Segi (1960) and used in the published volumes of the series ***Cancer Incidence*** in ***Five Continents.*** Its widespread use greatly facilitates the comparison of cancer levels between areas.

By denoting w_i as the population present in the i^{th} age class of the Standard population, i = 1, 2, ... A and letting a_i represent the age specific rate in the i^{th} age class, the age-standardized rate (ASR) is calculated as

$$ASR = \frac{\sum_{i=1}^{A} a_i w_i}{\sum_{i=1}^{A} w_i}$$

Percentage distribution

The percentage distribution tells us about how the entire population is divided into different age groups & the distribution of cancer cases among the various age-groups. This helps us to interpret if the cancer cases occur proportionately in the different age groups. Any variation in the proportion of population and cancer cases indirectly highlights the relationship of age and a particular cancer type.

Cumulative risk

Breslow and Day (1987) proposed the cumulative rate as another age-standardized incidence rate. In Volume IV of the series Cancer Incidence in Five Continents, this measure replaced the European and African standard population calculations (Waterhouse et al., 1982). The cumulative risk is the risk which an individual would have of developing the cancer in question during a certain age span if no other causes of death were in operation. It is essential to specify the age period over which the risk is accumulated- usually this is 0-74, representing the whole life span.

For childhood cancers, 0-14 can be used.

The cumulative rate is the sum over each year of age of the age-specific incidence rates, taken from birth to age 74 for the 0-74 rate. It can be interpreted either as a directly age-standardized rate with the same population size in each age group, or as an approximation to the cumulative risk.

If a_i is the age-specific incidence rate in the i^{th} age class which is t_i years long, then cumulative rate can be expressed as

$$Cumulative\ Rate = \sum_{i=1}^{A} a_i t_i$$

where the sum is until age class A.

It is more common to express this quantity as a percentage rather than per 1,*00,000*. The cumulative risk has been shown by Day (1987) to be

$$Cumulative\ Risk = 100 \text{ x } \left[1 - e^{(-cumulative\ \ rate\ /100}\right]$$

Table 7: Cumulative rates and cumulative risks, all sites combined, Males, 2006-2008

before age	BARSHI		MUMBAI		AURANGABAD		PUNE	
	cum. Rate	cum. Risk	cum. Rate	cum. Risk	cum. Rate	cum. Risk	cum. Rate	cum. Risk
15	0.13	0.13	0.14	0.14	0.06	0.06	0.08	0.08
30	0.32	0.32	0.28	0.28	0.23	0.23	0.19	0.19
55	1.38	1.37	1.92	1.91	1.43	1.42	1.43	1.42
75	4.85	4.73	10.10	9.60	7.38	7.11	8.22	7.89

It can be seen from table 7 that, for all the 4 registries, all cancers have their cumulative risk increasing with increase in age among males. It is maximum in older age group, that is, before age 75.

Similarly, it can be seen from table 8 below that, for all the 4 registries, all cancers have their cumulative risk increasing with increase in age among females and it is maximum in older age group, that is, before age 75.

Table 8: Cumulative rates and cumulative risks, all sites combined, Females, 2006-2008

before age	BARSHI		MUMBAI		AURANGABAD		PUNE	
	cum. Rate	cum. Risk	cum. Rate	cum. Risk	cum. Rate	cum. Risk	cum. Rate	cum. Risk
15	0.055	0.055	0.091	0.091	0.065	0.065	0.063	0.063
30	0.160	0.159	0.330	0.329	0.248	0.248	0.194	0.194
55	2.043	2.022	3.406	3.349	1.660	1.647	2.343	2.316
75	5.199	5.066	11.528	10.888	6.508	6.301	9.072	8.673

Table 9: Age-specific rates, all sites combined and different Site wise, Males and Females, 2006-2008

age-group	Name of the Registry	Males				Females		
		All Sites	C0-14	C15-26	C30-39	All Sites	C50	C53
0-14	Barshi	9.00	0.36	0.72	0	3.67	0.00	0.00
	Mumbai	9.49	0.21	0.35	0.096	6.05	0.09	0.00
	Aurangabad	3.73	0.16	0.00	0	4.31	0.00	0.00
	Pune	5.19	0.20	0.00	0.05	4.19	0.17	0.00
15-29	Barshi	12.14	0.93	0.47	0.47	6.97	0.00	0.00
	Mumbai	9.43	1.21	0.93	0.30	15.92	5.17	0.53
	Aurangabad	11.64	1.72	1.72	0.95	12.23	0.40	0.40
	Pune	7.56	0.66	0.87	0.29	8.73	1.02	0.63
30-54	Barshi	42.39	7.45	11.18	4.66	75.34	14.97	23.95
	Mumbai	65.60	18.30	14.96	7.77	123.07	45.35	21.24
	Aurangabad	47.87	13.59	7.85	7.66	56.49	25.53	18.30
	Pune	49.68	12.63	11.91	6.38	85.98	29.51	15.93
55-74	Barshi	173.49	27.25	58.13	21.80	157.79	19.82	45.74
	Mumbai	408.63	74.73	118.26	72.29	406.06	111.10	48.60
	Aurangabad	297.48	55.94	68.38	77.25	242.39	54.99	48.48
	Pune	339.46	63.86	99.87	55.16	336.46	93.61	47.06
Total	Barshi	237.01				243.77		
	Mumbai	493.15				551.10		
	Aurangabad	360.71				315.42		
	Pune	401.89				435.36		

Table 9 above shows that age-specific incidence rates are increasing with increase in age, among males and females both. The most common sites among males are lip, oral cavity & pharynx (C0-14), digestive organs (C15-26) and lip, oral cavity & pharynx (C0-14) and respiratory systems (C30-39) whereas among females they are breast (C50) and cervix uteri (C53).

Table 10: Age-standardized rates, all sites combined and different site wise, Males and Females, 2006-2008

Name of the Registry	Males All Sites	C0-14	C15-26	C30-39	Females All Sites	C50	C53
Barshi	41.50	6.17	11.37	4.39	46.17	7.06	13.15
Mumbai	79.02	15.70	20.46	12.00	96.26	29.50	12.86
Aurangabad	57.77	11.93	11.83	12.76	53.35	14.95	11.95
Pune	63.30	12.44	16.99	9.29	73.63	21.46	11.12

Cancer Mortality

Table 11: Number of Deaths, Males, 2006-2008

Site Code ICD-10	Site Name	Name of the Registry	Age-groups 0-14	15-29	30-54	55-74	Total
C0-14	**lip, oral cavity & pharynx**	Barshi	0	0	10	18	28
		Mumbai	2	10	469	581	1062
		Aurangabad	0	0	7	4	11
		Pune	1	3	70	99	173
C15-26	**digestive organs**	Barshi	0	2	13	39	54
		Mumbai	5	24	562	1407	1998
		Aurangabad	0	0	8	17	25
		Pune	0	7	107	300	414
C30-39	**respiratory systems**	Barshi	0	1	2	15	18
		Mumbai	0	7	296	792	1095
		Aurangabad	0	1	9	19	29
		Pune	0	4	46	128	178
C60-68	**urinary + genital**	Barshi	0	0	6	14	20
		Mumbai	6	11	102	448	567
		Aurangabad	0	0	3	6	9
		Pune	0	1	15	101	117
C81-90	**lymphatic systems**	Barshi	0	1	4	2	7
		Mumbai	19	28	152	279	478
		Aurangabad	1	0	4	3	8
		Pune	8	5	33	55	101
C91-95	**Leukemia**	Barshi	7	3	4	4	18
		Mumbai	125	71	132	125	453
		Aurangabad	2	4	5	5	16
		Pune	15	13	22	31	81
	All sites combined	Barshi	11	13	62	172	258
		Mumbai	197	232	1967	4021	6417
		Aurangabad	4	7	50	61	122
		Pune	32	54	347	790	1223

Table 12: Number of Deaths, Females, 2006-2008

Site Code ICD-10	Site Name	Name of the Registry	Age-groups				
			0-14	15-29	30-54	55-74	Total
C0-14	lip, oral cavity & pharynx	Barshi	0	1	1	4	6
		Mumbai	5	11	166	249	431
		Aurangabad	1	1	3	2	7
		Pune	0	0	44	50	94
C15-26	digestive organs	Barshi	0	0	12	16	28
		Mumbai	5	32	437	799	1273
		Aurangabad	0	0	6	6	12
		Pune	0	6	75	166	247
C30-39	respiratory systems	Barshi	0	0	1	6	7
		Mumbai	4	4	127	261	396
		Aurangabad	0	2	4	3	9
		Pune	0	2	37	67	106
C50	breast	Barshi	0	0	6	8	14
		Mumbai	0	30	658	719	1407
		Aurangabad	0	0	8	8	16
		Pune	0	2	173	181	356
C53	cervix uteri	Barshi	0	0	13	33	46
		Mumbai	0	6	249	273	528
		Aurangabad	0	0	9	5	14
		Pune	0	2	67	66	135
C51-58	other female genital	Barshi	0	1	4	11	16
		Mumbai	3	14	218	416	651
		Aurangabad	0	0	4	6	10
		Pune	0	4	48	107	159
C64-68	urinary organs	Barshi	0	0	0	1	1
		Mumbai	2	2	19	79	102
		Aurangabad	0	0	1	1	2
		Pune	0	1	3	19	23
C81-90	lymphatic systems	Barshi	1	0	0	1	2
		Mumbai	6	7	109	199	321
		Aurangabad	0	0	0	0	0
		Pune	1	3	16	40	60
C91-95	Leukemia	Barshi	1	1	6	2	10
		Mumbai	80	51	101	101	333
		Aurangabad	3	1	4	4	12
		Pune	13	12	29	27	81
	All sites combined	Barshi	10	7	84	155	256
		Mumbai	118	178	2150	3112	5558
		Aurangabad	5	4	42	40	91
		Pune	17	30	392	582	1021

The tables 11 and 12 consist of the data regarding number of deaths, among males and females, during period 2006 to 2008, in the four registries under consideration. The data is obtained for the different sites with respect to different age groups. From these tables, the most common site for cancer mortality among male and female can be observed. Moreover the age group in which the most number of deaths occurred can also be observed.

From table 11, it can be observed that the most number of deaths among males occurred in the age groups of 30-54 and 55-74 years. Also the highest number of deaths occurred due to cancer site of digestive organs (C15-26), the next highest number of deaths were due to respiratory systems related cancers (C30-39) and then the third highest was lip, oral cavity and pharynx (C0-14).

From table 12, it can be observed that the most number of deaths among females occurred in the age groups of 30-54 and 55-74 years. Also the highest number of deaths occurred due to cancer site of breast (C50), the next highest number of deaths were due to cervix uteri related cancers (C53) and then the third highest was other female genital (C51-58).

Table 13: Crude Mortality Rate, Males, 2006-2008

ICD-10 region	C0-14 lip, oral cavity& pharynx	C15-26 digestive organs	C30-39 respiratory systems	C60-68 urinary +genital	C81-90 lymphatic systems	C91-95 leukemia	all sites combined
BARSHI	3.43	6.61	2.20	2.45	0.86	2.20	31.59
MUMBAI	4.79	9.01	4.94	2.56	2.16	2.04	28.93
AURANGABAD	0.62	1.41	1.63	0.51	0.45	0.90	6.87
PUNE	2.37	5.67	2.44	1.60	1.38	1.11	16.76

From table 13, it is evident that overall crude mortality rate is highest in Barshi and then in Mumbai, among males. Comparing them site wise, it can be observed that the crude mortality rate is the highest due to cancer related to digestive organs and then due to lip, oral cavity and pharynx.

From table 14, it is evident that overall crude mortality rate is highest in Barshi and then in Mumbai, among females. Comparing them site wise, it can be observed that the crude mortality rate is the highest due to breast cancer and then cancer related to digestive organs and then due to cervix uteri and other female genital organs.

Table 14: Crude Mortality Rate, Females, 2006-2008

ICD-10 region	C0-14 lip, oral cavity& pharynx	C15-26 dige. organs	C30-39 Resp. syst.	C50 breast	C53 cervix uteri	C51-58 other female genital	C64-68 urin. org.	C81-90 lymp. Syst.	C91-95 leukemia	all sites
BARSHI	0.73	3.43	0.86	1.71	5.63	1.96	0.12	0.24	1.22	31.34
MUMBAI	1.94	5.74	1.79	6.34	2.38	2.94	0.46	1.45	1.50	25.06
AURANGABAD	0.39	0.68	0.51	0.90	0.79	0.56	0.11	0.00	0.68	5.13
PUNE	1.29	3.39	1.45	4.88	1.85	2.18	0.32	0.82	1.11	13.99

Table 15: Age-Specific Mortality Rate, Males, All sites combined

age-group	Barshi	Mumbai	Aurangabad	Pune
0--14	3.96	3.78	0.65	1.63
15--29	6.07	3.01	1.34	2.24
30--54	28.88	26.41	9.57	14.76
55-74	156.23	223.25	54.17	137.45
TOTAL	195.14	256.44	65.73	156.09

Table 16: Age-Specific Mortality Rates- Females, All sites combined

age-group	Barshi	Mumbai	Aurangabad	Pune
0--14	4.08	2.54	0.94	0.96
15--29	4.07	3.35	0.80	1.46
30--54	41.91	35.68	9.49	18.48
55-74	118.15	178.13	28.94	97.81
TOTAL	168.21	219.69	40.17	118.72

From tables 15 and 16, it is evident that the actual mortality rate is increasing with the increase in age, among all four registries, in males as well as females.

Table 17: Age-Standardized Mortality Rate, All sites combined

Registry	Males	Females
Barshi	10.69	10.13
Mumbai	13.13	11.95
Aurangabad	3.52	2.38
Pune	7.90	6.37

Table 17 shows that, the age-standardized mortality rates are the highest in Mumbai among males as well as females, next is in Barshi and that too among males and females both.

Log-linear models

All the comparisons have been made assuming that the age-specific rates (ASR) are constant; (that is, population distribution in the various registries is same). But using log-linear models, we assume the ASR is not constant for all the age-groups in different registries. We can even observe the same in our analysis.

The log-linear model is used to calculate Incidence Rate Ratio (IRR) which is adjusted for age. The analysis was carried out using the software STATA 9. The commands for the respective objectives were fed.

The IRR values are calculated for the Mumbai, Aurangabad and Pune registries relative to Barshi registry.

Table 18: Incidence Rate Ratio, Males, 2006-2008

area/site	Barshi *		Mumbai		Aurangabad		Pune	
	IRR	95 % C.I	IRR	95% C.I	IRR	95% C.I	IRR	95% C.I
head & neck	1	-	2.67	(2.01,3.55)	2.05	(1.48,2.84)	2.04	(1.53,2.73)
Digestive	1	-	1.83	(1.49,2.26)	1.07	(0.81,1.40)	1.51	(1.22,1.88)
Respiratory	1	-	2.8	(2.00,3.90)	2.98	(2.05,4.33)	2.19	(1.55,3.09)
genital + urinary	1	-	1.8	(1.34,2.42)	1.09	(0.74,1.60)	1.54	(1.13,2.09)
lymphatic	1	-	1.97	(1.29,3.01)	1.34	(0.81,2.22)	1.5	(0.97,2.33)
leukemia	1	-	1.09	(0.73,1.62)	0.86	(0.52,1.4)	0.64	(0.42,0.98)
ALL SITES	1	-	1.87	(1.68,2.09)	1.39	(1.22,1.59)	1.49	(1.33,1.66)

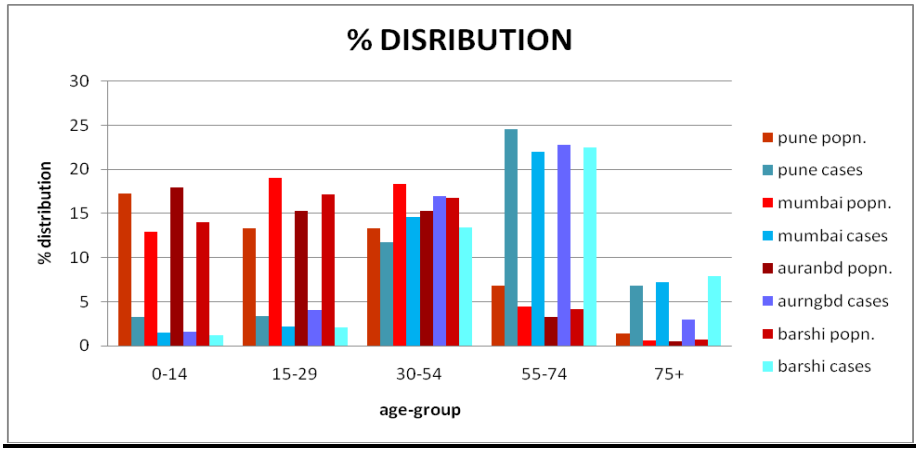
From table 18, we can observe that the incidence rates ratios are more in Mumbai, Aurangabad and Pune as compared to Barshi for all sites, among males.

Table 19: Incidence Rate Ratio, Females, 2006-2008

area/site	Barshi *		Mumbai		Aurangabad		Pune	
	IRR	95% C.I	IRR	95% C.I	IRR	95% C.I	IRR	95% C.I
head & neck	1	-	4.72	(2.67,8.35)	3.76	(2.02,6.97)	4.77	(2.68,8.49)
digestive	1	-	2.46	(1.88,3.22)	1.23	(0.87,1.72)	1.71	(1.29,2.27)
respiratory	1	-	1.74	(1.13,2.66)	1.45	(0.86,2.44)	1.57	(1.01,2.45)
Breast	1	-	4.8	(3.69,6.25)	2.33	(1.73,3.15)	3.34	(2.55,4.37)
Cervix	1	-	1.1	(0.9,1.3)	0.96	(0.75,1.24)	0.92	(0.75,1.13)
other genital	1	-	2.24	(1.67,3.02)	0.92	(0.62,1.36)	1.52	(1.12,2.08)
lymphatic			2.88	(1.63,5.11)	1.17	(0.57,2.39)	1.86	(1.03,3.36)
leukemia	1	-	1.41	(0.84,2.35)	1.35	(0.75,2.46)	0.82	(0.47,1.41)
ALL SITES	1	-	2.26	(2.04,2.5)	1.34	(1.18,1.52)	1.68	(1.51,1.87)

From table 18, we can observe that the incidence rates ratios are more in Mumbai, Aurangabad and Pune as compared to Barshi for all sites, among females.

Cancer Incidence



The graph above clearly shows that in early age-groups, that is, below 15 years of age the incidence of cancer is low even though population is large whereas, in older age groups, the incidence is high even if their population contributes very scarcely to the overall population. This is true for all the 4 registries.

Childhood Cancer

Table 20: Males and Females combined, 2006-2008

ICD10	Site	Barshi Total no. of cases	%	Mumbai Total no. of cases	%	Aurangabad Total no. of cases	%	Pune Total no. of cases	%
C0-14	lip, oral cavity& pharynx	1	5	31	5.65	3	8.33	6	6.12
C15-26	digestive organs	2	10	29	5.28	0	0	2	2.04
C30-39	respiratory systems	0	0	10	1.82	0	0	1	1.02
C50	breast	0	0	4	0.73	0	0	3	3.06
C60-63	male genital organs	0	0	26	4.74	0	0	5	5.10
C64-68	urinary organs	2	10	25	4.55	4	11.11	7	7.14
C81-90	lymphatic systems	5	25	93	16.94	8	22.22	24	24.49
C91-95	leukemia	10	50	331	60.29	21	58.33	50	51.02
TOTAL		20	100	549	100	36	100	98	100

Table 20 gives the number and relative proportion of cancer site groups of pediatric age group. All the registries show that Leukemias constitute the vast majority of childhood cancers, in both males & females.

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