RESEARCH ARTICLE

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A Glimpse into the Epidemiology of Geriatric Cancers in India: Report from the Indian Population Based Cancer Registries

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Abstract

Introduction: Indian population is aging and the cancer rates are rising. Older adults (OAs)(≥60 years) with cancer require specialized care. However, data on geriatric cancer epidemiology is scarce. **Methods:** The study compiled the geriatric cancer data from the published reports(2012-2014) of Indian population-based cancer registries(PBCRs). **Results:** Of the 1,61,363 cancers registered in the Indian PBCRs, 72,446(44.9%) occur in OAs, with 21,805(30.1%), 18,349(25.3%), 14,645(20.2%), and 17,647(24.4%) occurring in 60-64, 65-69, 70-74, and ≥75year age groups. The truncated incidence rates for OAs are 555.9,404.5, and 481.9 for males, females, and OA populations respectively. The common cancers are lung, prostate, and esophagus cancers in males, breast, cervix, and lung in females. The overall common cancers are lung, prostate, and breast. While >50% of the incident cases of prostate, and bladder cancers occurred in OAs, <20% of Hodgkin lymphoma and thyroid cancers occurred in OAs. OA cancer epidemiology has a regional variation, highest in South India and lowest in Western India.**Conclusion:** The current study quantifies the cancer burden in the Indian geriatric population. Understanding the epidemiology of geriatric cancers is vital to health program planning and implementation. Increased awareness, focused resource allocation, research, and national policies for streamlining care will all help to improve geriatric cancer outcomes.

Keywords: Epidemiology- geriatric cancers- India- population-based cancer registries- older adults with cancer

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Introduction

India is now the most populous country in the world [1]. Combined with the increase of life expectancy by nearly one decade, from the 1980s to the 2020s, the proportion of older adults(OA) (≥ 60 years of age) is also increasing in India [2]. The number of OAs is 149 million, around 10.5% of the Indian population. Also, the cancer incidence in India is increasing, termed a cancer tsunami or epidemic [3, 4].Thus, there is an increasing incidence of cancers in OAs [5, 6]. There is also a global predicted increase in geriatric cancers [7]. Though the United Nations defines 'older persons' as those aged over 60 years, different organizations and geriatric societies have used different age cutoff for OAs; the International Society of Geriatric oncology (SIOG) uses 70 years while American Society of Clinical Oncology(ASCO) uses 65 years [8, 9]. In India, most geriatric cancer reports include patients ≥ 60 years of age due to the retirement age, the age cut-off for governmental schemes, and the average life expectancy [10-12].

Geriatric cancers may have a distinct biology; however, it is undisputed that OAs with cancer require special care from both disease and psychosocial perspectives [13-15]. A comprehensive geriatric assessment(GA) changes the management of the patients, emphasizing the need for such evaluations in day-to-day oncologic practice [16] Despite the need for GA, many oncology facilities do not have access to a specialized geriatric clinic facility for the performance of GA. Oncologists have to resort to 'intuitive' assessments with basic laboratory reports for assessing the fitness of geriatric patients, which may not be ideal [16, 17].There are several challenges in geriatric oncology practice in India, with a shortage of trained doctors and an uneven distribution of tertiary cancer care centers in India [18-20]. There are very few centers with

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provision for specialty-based oncology practice [19, 20]. Fewer geriatric training programs also lead to a lack of specially trained physicians. There are only 69 seats for specialty training in geriatrics in India, as opposed to 448 emergency medicine and 5,179 general medicine seats [21]. Cancer registration and population based cancer registries (PBCRs) were established in India since the 1960s, with addition of increasing network of registries over the past few decades. Though it covers only around 10% of the population, the wide distribution and the meticulous quality assurance protocols makes the PBCRs an immense data source, for compiling epidemiological data and guiding cancer care policies and health planning [22-24].

Understanding the burden of geriatric cancers in India and the detailed epidemiology may help to improve awareness among all the stakeholders. The healthcare systems need immense support with infrastructure and the workforce to meet the overwhelming needs of the OA population [6, 25]. Though there are reports of cancer epidemiology in OAs, Indian epidemiologic data is scarce, mostly from single centers/areas [1, 7, 25-27]. The current study attempts to trace the Indian geriatric cancer epidemiology comprehensively from the PBCR data.

Materials and Methods

Data sources

For mapping the epidemiology of geriatric cancers at the national level, the study accessed the reports of 27 population-based cancer registries(PBCR) covering various parts of India, during 2012-2014 The PBCRs included were Delhi (2012), Bhopal (2012-13), Wardha (2012-14), Patiala (2012-14), and Nagpur (2012-13) from North/Central India; Thiruvananthapuram (2012-14), Kollam (2012-14), Chennai (2012-13), and Bengaluru (2012) from South India; Pune (2012-13), Ahmedabad (2012-2013), Aurangabad (2012-14), Mumbai (2012), Barshi [Rural (2012-14), expanded (2012)] from West India; and Tripura (2012-14), Meghalaya (2012-14), Sikkim (2012-14), Kolkata (2012), Pasighat (2012-14), Naharlagun (2012-14), Nagaland (2012-14), Manipur (2012-14), Mizoram (2012-14), Dibrugarh (2012-14), Kamrup (2012-14), and Cachar (2012-14) from East/ North-East(NE) India [11]. The Indian PBCRs are mostly urban, urban and rural or only rural [2, 23]. The Indian Council of Medical Research(ICMR) publishes the reports as a part of the National Cancer Registry Programme and are available at https://www.ncdirindia.org/All_Reports/ Report_2020/default.aspx.

Quality of the included PBCRs

The PBCRs in India follow the standard quality norms and undergo rigorous quality checks at multiple levels. The procedure of data collection and the quality of PBCR data has been reported by prior studies [28, 29]. In brief, the PBCRs collect data from a prespecified geographic region. The method of cancer case detection is active, with data collected from hospitals, diagnostic centers and death certificates. The cancer cases are coded with International Classification of Diseases for Oncology (ICD-O) and entered. The cancer registries follow the international norms for quality control, and undergo multistage quality assurance checkpoints under the Indian Council of Medical Research (ICMR) [23]. The percentage of death-certificate-only, microscopically verified cases and the percentage of 'other and unknown' cancer sites are also at acceptable levels, as previously reported [30].

Calculation of the geriatric cancer rates

The data on geriatric cancers were extracted from all the reports. This study summed up the total number of cases of each cancer type as per the ICD classification (International Classification of Diseases ICD nomenclature) among men, women, and the total population at risk (above 60) from each PBCR. The PBCR reports consist of a population pyramid providing the total population covered and the constitution of the population, in terms of age groups.

Statistical analysis

The crude rates(CR) were calculated by dividing the total number of cases by the total population; multiplied by 100,000. The age-specific incidence rates for each cancer type was calculated for this study by dividing the total number of cases of all the cancers in persons ≥60 years by the total population at risk (the sum of the population ≥60 years of age in the included PBCRs). The age-adjusted rates were calculated by multiplying each of the age-specific rates with the weight of the population of the corresponding age-group, as per the World standard population [31].The standard error was calculated as the square root of the calculated variance, as per standard method. The limits of the 95% confidence interval were calculated with the formula, $x\pm 1.96\ s/\sqrt{n}$ (x= mean, s=standard error, n=sample size. The percentage of geriatric cases among each cancer type, age distribution, and the common cancers in the geriatric age group were analysed. For each PBCR, truncated incidence rates and age-standardized rates were calculated for comparison. Further, regional data was summarized for comparison of data from different parts of India (North and Central India, East and NE India, South India, and West India). The study was reported in line with the recommended REPCAN guidelines [32].

Ethical concerns

The data was collected from the published reports of the PBCRs available on a public database. Moreover, only depersonalized data was available in PBCRs. Hence ethical clearance was not required.

Results

In the reported period, there were 1,61,363 cancers registered in the PBCRs. Of them, 72,446 (44.9%) occurred in persons older than 60. The total population covered by the PBCRs is 171535,042 with 15032646(8.8%) persons over 60 years of age. On further analyzing the age distribution of OAs with cancer, 21,805(30.1%), 18,349(25.3%), 14,645(20.2%), and 17,647(24.4%) occurred in the 60-64, 65-69, 70-74, and ≥75 year age

groups respectively which constituted 13.5%, 11.4%, 9.1%, and 11% of the total number of cases reported in the PBCRs. The age-specific incidence rates for ≥ 60 years were 555.9 per 100,000 males and 404.5 per 100,000 women (Table 1).

Among men, the most common cancer sites in the OAs were lung, prostate, esophagus, stomach and mouth cancers. In contrast, the corresponding sites among OA women were breast, cervix, lung, ovary and esophagus. The most common sites overall in the geriatric population were lung, prostate, breast, cervix and esophageal cancers. (Table 2) The incidence difference between male and female cancers was most apparent for lung, larynx, stomach, esophageal, hypopharynx, bladder liver, tongue, mouth, colorectal, kidney malignancies (male >female) while gallbladder cancers were more common in women OAs (Supplementary Tables 1 and 2).

On analyzing the proportion of cases occurring in OAs, 88.8% of prostate cancer occurred in OAs. OAs with cancer formed more than 50% of the incident cancers in sites like bladder, ureter, lung, multiple myeloma and larynx and <20% of Hodgkin lymphoma, thyroid, lymphoid leukemias, adrenal and testicular malignancies. (Supplementary Table 3)

Further, exploring the geriatric cancer rates in each registry, the rates were higher in Kamrup, Mizoram, Delhi, and Mumbai registries while lowest in Barshi, Wardha, Aurangabad, and Tripura.(Table 3) To understand the regional variations better, the PBCRs were grouped into four regions – North and Central, West, East and NE, and South, including five, six, twelve, and four registries in each area. (Supplementary table 4) The ASR was highest in South India (556.9) and lowest in the West (410.4). The proportion of geriatric cancers was also lowest in North/Central registries, where only 40.6% of all cancers occurred in OAs.

Discussion

The current study systematically explores the cancer burden, incidence rates and the regional variations of geriatric cancers in India from the consolidated actuarial data of the Indian PBCRs. The study reports that 44.9% of the total incident cancers occur in OAs in India, though the truncated incidence rates of geriatric cancers are lower, nearly half of the world rates [7].The geriatric cancer rates also vary markedly across the nation, with the highest rates in South India and the lowest rates in West India.

The lower geriatric cancer rates in India may reflect the overall lower cancer incidence rates in India [3, 5]. The international report on geriatric cancer epidemiology has looked into the estimated cancer cases in persons older than 80 years rather than the actual numbers [26]. The rates of cancers varied from 550 (India), 745 (south Central Asia excluding India),967 (Africa) and 1613 (World), revealing that the cancer rates are lower in India, even among the OAs, though comparable with Africa and some other parts of Asia [26]. However, the changes between the top cancers in the international and national lists reflect the differences in cancer epidemiology overall, as cervical, oral cavity and esophageal cancers are common in India. The GLOBOCAN data reported breast, lip/oral cavity, cervical, lung and esophageal cancers as the most common cancers in India [33]. The common cancers in OAs reported in the international study were prostate, lung, colorectal, liver and stomach cancers [7]. Though prostate cancer is a disease of the OAs, [34] lung cancer seems to have a higher incidence than prostate cancer in Indian OAs. However, there is no robust screening program for prostate cancers in India, as compared to globally, hence the detection rates may be lower [35, 36].

Comparing to the common cancers and their estimated crude incidence rates in persons between 30-59 years; breast (CR 45.2), cervical (CR 31.5), ovarian (CR 10.4), oral cavity (CR 7) and esophageal cancers(CR 4.6) are common in women; and oral cavity (CR 22.8), esophagus(CR 8.4), lung(CR 7.2), colorectal (CR 6.6) and stomach (CR 6.6) cancers are common in men [37] (Table 2). Mathur et al have detailed the Adolescent and Young adult (AYA) cancer epidemiology in India, reporting highest incidence rates of breast, thyroid, mouth and brain/nervous system cancer [29]. The geriatric cancer incidence rates of 556 and 405 per 100,000 men and women are more than ten times the rates reported in the AYA population (22.2 and 29.2 respectively among men and women) [29]. The cancer rates in the 30-59 years of age are also much lower, 130.7 and 123.5 respectively among men and women [37]. As expected the cancer occurrence patterns are different in the different age groups. The cancers with a genetic basis of causation are found at an earlier age, while cancers with a predominant causation due to environmental exposure are seen at later ages. Also, there are some cancers which are seen in OAs, like prostate cancer and plasma cell neoplasms, leading to an increased proportion of such cancers in the OA age group, compared to lymphoid leukemias, Hodgkin lymphoma and thyroid malignancies which are seen in younger patients.

Cervical cancer is also among the common cancers among the Indian OAs, as the median age of occurrence of cervical cancer in India is 56 years and nearly one-third of the cervical cancer cases occur in the 50-59 year age group [38, 39]. The OAs with cervical cancer form only around 35% of the total numbers, with the age groups of 60-64, 65-69, 70-74 and 75+ years contributing 13%, 10%, 6% and 7% each.Though the rates of cervical cancer are decreasing, cervical cancer is still the second most common cancer among women in India [33]. In India, breast cancer on an average has a lower age of onset, compared to global breast cancer epidemiology, probably explaining the lower incidence of breast cancer among OAs when compared to the overall numbers [40-42]. Though the burden of head and neck cancers is high among the OAs, the current study analyzed the subsites of mouth (ICD C03-06) and tongue (C01-02) separately as per the PBCR data (Table 2). Prostate and esophageal cancers among men and breast and cervical cancers among women are also common among the OA population in Sub-Saharan Africa, according to another PBCR-based study. However, cancers in OAs represented only 34% of the incident cancers in the report, compared to nearly 50% in India [43].

Table 1. Summary of the Geriatric Cancer Disposition in India, with the Cancer Incidence Rates in Persons >60 Years of Age (2012-2014)

ICD codes	Cancer site	No. of cancers in each age group				Age-specific rates				Geriatric incidence rates	ASR	TR	SE	95% CI (for ASR)	
		60-64	65-69	70-74	75+	60-64	65-69	70-74	75+					Lower limit	Upper limit
C00	Lip	60	59	44	66	1.1	1.6	1.7	2	1.5	1.5	1.5	0.1	1.3	1.7
C01-02	Tongue	862	669	448	461	16	18	16.9	14.1	16.2	16.4	16.3	0.33	15.63	16.93
C03-06	Mouth	1218	911	656	790	22.5	24.5	24.7	24.2	23.8	23.8	23.6	0.4	22.82	24.39
C07-08	Salivary glands	96	71	60	41	1.8	1.9	2.3	1.3	1.8	1.8	1.8	0.11	1.59	2.02
C09	Tonsil	203	155	97	112	3.8	4.2	3.7	3.4	3.8	3.8	3.7	0.16	3.43	4.05
C10	Oth. Oropharynx	175	140	107	103	3.2	3.8	4	3.2	3.5	3.5	3.5	0.15	3.2	3.81
C11	Nasopharynx	110	87	55	56	2	2.3	2.1	1.7	2	2.1	2	0.12	1.78	2.25
C12-13	Hypopharynx	527	433	335	369	9.8	11.7	12.6	11.3	11.1	11.1	11	0.27	10.5	11.57
C14	Pharynx uns.	103	67	78	95	1.9	1.8	2.9	2.9	2.3	2.3	2.2	0.12	2.01	2.49
C15	Oesophagus	1318	1104	909	1037	24.4	29.7	34.3	31.8	29.1	29	28.7	0.44	27.85	29.57
C16	Stomach	990	931	759	920	18.3	25.1	28.6	28.2	23.9	23.9	23.5	0.4	22.76	24.33
C17	Small intestine	49	49	34	38	0.9	1.3	1.3	1.2	1.1	1.1	1.1	0.09	0.96	1.31
C18	Colon	527	560	388	560	9.8	15.1	14.6	17.2	13.5	13.5	13.4	0.3	12.82	14
C19-20	Rectum	590	516	402	486	10.9	13.9	15.2	14.9	13.3	13.2	13.2	0.3	12.63	13.79
C21	Anus	66	68	53	57	1.2	1.8	2	1.7	1.6	1.6	1.6	0.1	1.41	1.82
C22	Liver	655	544	517	604	12.1	14.6	19.5	18.5	15.4	15.3	15.1	0.32	14.5	15.76
C23-24	Gallbladder etc.	734	562	447	456	13.6	15.1	16.9	14	14.6	14.7	14.4	0.31	13.81	15.04
C25	Pancreas	308	277	241	279	5.7	7.5	9.1	8.5	7.4	7.3	7.3	0.22	6.83	7.69
C30-31	Nose, sinuses etc.	65	57	46	57	1.2	1.5	1.7	1.7	1.5	1.5	1.5	0.1	1.29	1.68
C32	Larynx	744	636	448	483	13.8	17.1	16.9	14.8	15.4	15.5	15.3	0.32	14.71	15.97
C33-34	Lung	2214	2009	1775	1990	41	54.1	66.9	61	53.1	53	52.7	0.59	51.55	53.88
C37-38	Oth thoracic organs	47	28	22	24	0.9	0.8	0.8	0.7	0.8	0.8	0.8	0.07	0.65	0.94
C40-41	Bone	117	79	80	73	2.2	2.1	3	2.2	2.3	2.3	2.3	0.12	2.05	2.54
C43	Melanoma of skin	67	55	54	56	1.2	1.5	2	1.7	1.5	1.5	1.5	0.1	1.34	1.74
C44	Oth skin	258	215	224	378	4.8	5.8	8.4	11.6	7.2	7	6.9	0.21	6.5	7.33
C45	Mesothelioma	5	2	0	1	0.1	0.1	0	0	0.1	0.1	0.1	0.02	0.02	0.09
C46	KS	0	3	2	0	0	0.1	0.1	0	0	0	0	0.02	0	0.07
C47,C49	Conn & ST	131	105	79	94	2.4	2.8	3	2.9	2.7	2.7	2.7	0.14	2.45	2.98
C50	Breast	2546	1792	1229	1362	47.1	48.2	46.3	41.7	46.1	46.4	46.1	0.56	44.99	47.18

* Other and unspecified malignant neoplasms of lymphoid, hematopoietic and related tissue; ASR, Age standardised rates, TR truncated rates; SE, standard error; CI, confidence interval; Malig Imn.Prol D Malignant immunoproliferative disease; O & U, Other and Unspecified, Oth Other, uns unspecified,uri urinary, NHL non-Hodgkins lymphoma, leuk leukemia, MGO male genital organs, FGO female genital organs, KS Kaposi sarcoma, Conn and ST – connective and soft tissue, Ns nervous system

Table 1. Continued

ICD codes	Cancer site	No. of cancers in each age group				Age-specific rates				Geriatric incidence rates	ASR	TR	SE	95% CI (for ASR)	
		60-64	65-69	70-74	75+	60-64	65-69	70-74	75+					Lower limit	Upper limit
C51	Vulva	37	32	39	41	1.4	1.7	2.9	2.3	1.9	1.9	1.9	0.16	1.6	2.22
C52	Vagina	62	41	29	50	2.3	2.2	2.2	2.9	2.4	2.3	2.3	0.18	1.98	2.66
C53	Cervix uteri	1093	824	534	515	40.6	44	39.7	29.4	38.7	39.4	38.6	0.73	37.19	40.03
C54	Corpus uteri	448	342	158	136	16.7	18.3	11.8	7.8	14.2	14.6	14.5	0.45	13.68	15.42
C55	Uterus uns	68	54	44	48	2.5	2.9	3.3	2.7	2.8	2.8	2.8	0.19	2.41	3.16
C56	Ovary	533	428	304	318	19.8	22.9	22.6	18.2	20.7	20.9	20.6	0.53	19.57	21.63
C57	Oth FGO	5	5	4	4	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.06	0.13	0.35
C58	Placenta	0	0	1	0	0	0	0.1	0	0	0	0	0.01	-0.01	0.04
C60	Penis	107	81	58	108	3.9	4.4	4.4	7.1	4.8	4.7	4.7	0.25	4.24	5.23
C61	Prostate	552	757	843	1498	20.4	41.1	64.4	99	49.5	48.4	48.3	0.8	46.72	49.87
C62	Testis	20	10	13	14	0.7	0.5	1	0.9	0.8	0.8	0.8	0.1	0.57	0.96
C63	Oth MGO	1	6	2	2	0	0.3	0.2	0.1	0.1	0.2	0.2	0.05	0.06	0.25
C64	Kidney	258	232	169	177	4.8	6.2	6.4	5.4	5.6	5.6	5.5	0.19	5.16	5.92
C65	Renal pelvis	2	0	3	1	0	0	0.1	0	0	0	0	0.02	0	0.06
C66	Ureter	6	8	8	2	0.1	0.2	0.3	0.1	0.2	0.2	0.2	0.03	0.1	0.23
C67	Bladder	467	470	430	588	8.6	12.7	16.2	18	13	12.8	12.8	0.29	12.23	13.38
C68	O & U uri organs	5	3	6	2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.03	0.05	0.16
C69	Eye	15	12	12	10	0.3	0.3	0.5	0.3	0.3	0.3	0.3	0.05	0.23	0.41
C70-72	Brain, NS	338	252	159	183	6.3	6.8	6	5.6	6.2	6.2	6.2	0.21	5.78	6.58
C73	Thyroid	253	220	154	165	4.7	5.9	5.8	5.1	5.3	5.3	5.3	0.19	4.91	5.65
C74	Adrenal gland	10	7	1	3	0.2	0.2	0	0.1	0.1	0.1	0.1	0.03	0.08	0.2
C81	Hodgkin disease	76	52	38	60	1.4	1.4	1.4	1.8	1.5	1.5	1.5	0.1	1.29	1.68
C82-C85	NHL	533	469	363	445	9.9	12.6	13.7	13.6	12	12	12	0.28	11.44	12.55
C88	Malig Imn.Prol D	0	3	0	0	0	0.1	0	0	0	0	0	0.01	0	0.05
C90	Multiple myeloma	312	284	246	271	5.8	7.6	9.3	8.3	7.4	7.4	7.4	0.22	6.92	7.79
C91	Lymphoid leuk.	117	98	96	99	2.2	2.6	3.6	3	2.7	2.7	2.7	0.13	2.44	2.97
C92-94	Myeloid leuk.	210	161	173	200	3.9	4.3	6.5	6.1	4.9	4.9	4.9	0.18	4.51	5.22
C95	Leukaemia uns	25	33	36	49	0.5	0.9	1.4	1.5	1	0.9	0.9	0.08	0.76	1.06
C96	O & U of hemat*	16	14	11	10	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.05	0.25	0.44
	O & U	1451	1267	1122	1600	26.9	34.1	42.3	49	36.2	35.7	35.5	0.49	34.53	36.43
Total		21805	18349	14645	17647	403.7	494	552.1	540.7	481.9	480.7	477.1	1.79	473.59	480.6

* Other and unspecified malignant neoplasms of lymphoid, hematopoietic and related tissue; ASR, Age standardised rates, TR truncated rates; SE, standard error; CI, confidence interval; Malig Imn.Prol D Malignant immunoproliferative disease; O & U, Other and Unspecified, Oth Other, uns unspecified,uri urinary, NHL non-Hodgkins lymphoma, leuk leukemia, MGO male genital organs, FGO female genital organs, KS Kaposi sarcoma, Conn and ST – connective and soft tissue, Ns nervous system

Table 2. A) Lists the top ten cancers and their incidence rates in the overall geriatric, men and women in India from the derived cancer incidence rates from the PBCR data (2012-2014); B) Lists the common cancers in the 30-59 years age group *

A) Common Cancers in Persons Older Than 60 Years					
Overall		Males		Females	
Cancer site	Incidence	Cancer site	Incidence	Cancer site	Incidence
Lung	53.1	Lung	79.9	Breast	86.8
Prostate	49.5	Prostate	49.5	Cervix	38.7
Breast	46.1	Oesophagus	38.1	Lung	27.3
Cervix	38.7	Stomach	33.1	Ovary	20.7
Oesophagus	29.1	Mouth	30.4	Oesophagus	20.3
Stomach	23.9	Larynx	27.9	Mouth	17.4
Mouth	23.8	Tongue	23.5	Gallbladder etc.	17.3
Ovary	20.7	Liver	23.3	Stomach	15.1
Tongue	16.2	Bladder	21.4	Corpus uteri	14.2
Liver	15.4	Hypopharynx	19.6	Colon	10.9
B) Common Cancers in the 30-59 Year Age Group					
Overall		Males		Females	
Cancer site	CR	Cancer site	CR	Cancer site	CR
Breast	45.2	Lip, oral cavity	22.8	Breast	45.2
Cervix uteri	30.1	Oesophagus	7.7	Cervix uteri	30.1
Lip, oral cavity	15	Trachea, bronchus and lung	6.6	Ovary	10
Ovary	10	Colorectum	6.2	Lip, oral cavity	6.6
Oesophagus	6.1	Stomach	6.1	Oesophagus	4.4
Colorectum	5.3	Larynx	4.5	Colorectum	4.4
Stomach	5.1	Hypopharynx	3.8	Stomach	3.9
Trachea, bronchus and lung	5	Non-Hodgkin lymphoma	3.8	Thyroid	3.8
Leukaemia	3.4	Leukaemia	3.6	Trachea, bronchus and lung	3.3
Corpus uteri	3.3	Liver and intrahepatic bile ducts	3.4	Corpus uteri	3.3

*The cancer incidence rates in the 30-59 years are estimated from the GLOBOCAN projections [37].

Similar to the overall cancer epidemiology, OA males have a higher incidence of lung, head and neck and bladder cancers while thyroid and gall bladder malignancies are more common in older women [44]. In a prior geriatric cancer epidemiology study from the Mumbai PBCR(2002-04), Yeole et al. [10] reported that lung, prostatic and breast and cervical cancers are the common cancers in OAs, similar to the current study. The current geriatric cancer rates of 555.9 and 404.5 per 100000 male and female OAs seem comparable with the older report from Mumbai. However, the lung cancer incidence seems higher in OA women and liver cancer incidence lower in OA men in the current study.However, the prior report explored the cancer incidence of only a single urban registry.

India is one of the most populous nations in the world, with a diverse population. The cancer epidemiology is distinct and varies between the different regions in India [45]. The country has a 'nation with nation' pattern of cancer incidence with vast variations in cancer incidence and distribution among the different states of India [45, 46]. Since each portion of India has distinct sociocultural, genetic and environmental profiles, the differences in cancer incidence may merely reflect such disparities. Even carcinogen exposures like arecanut have a wide regional disparity between states; there are also known genetic polymorphisms which may affect the carcinogenicity of the same [47-49]. Some cancers in India are known to have geographical clustering due to various putative factors, like gallbladder cancer in the Northern part of India. Infection associated cancers like hepatitis B related hepatocellular cancer and human papilloma virus(HPV) associated cancers also show geographic variations in India [50, 51]. Keeping with the unique epidemiology and population structures, the distribution of geriatric cancers varies across India. The study noted the highest geriatric age-standardized rates from Kamrup (Assam), Mizoram, Delhi and Mumbai and the lowest rates from the rural registry of Barshi and Wardha in Madhya Pradesh. The overall rates of cancer are highest in Aizawl (269.4), Kamrup, Mizoram and Delhi also with relatively higher rates compared to the rest of the country [29]. The North Eastern(NE) part of India consists of an ethnically and culturally distinct population, with a distinct genetic profile [52-54]. The tobacco use in the NE is among the highest in India, with a relatively high proportion of tobacco associated cancers, contributing to the major cancer burden [55, 28]. In addition to the increased cancer burden, NE region is also plagued with limited infrastructural and manpower resources and other logisitic isuses in access to quality cancer care, leading to

Table 3. Geriatric cancer rates in India from each PBCR*

PBCR name	Age group	Total no of cases in each age group	Total population in each age group	Age-specific rates for each age group	Age-standardised rate for each registry
Ahmedabad (2012-13)	60-64	1240	367,538	337.4	376.8
	65-70	963	233,587	412.3	
	71-74	721	169,648	425	
	75+	729	207,023	352.1	
Aurangabad (2012-14)	60-64	263	98,467	267.1	299.6
	65-70	267	75,293	354.6	
	71-74	177	49,937	354.4	
	75+	132	58,541	225.5	
Bangalore (2012)	60-64	1192	260,807	457	587.4
	65-70	996	169,529	587.5	
	71-74	792	111,891	707.8	
	75+	1048	144,698	724.3	
Barshi (2012)	60-64	295	159,046	185.5	179.2
	65-70	304	169,463	179.4	
	71-74	217	115,739	187.5	
	75+	182	115,864	157.1	
Barshi rural (2012-14)	60-64	125	58,694	213	252.9
	65-70	172	57,627	298.5	
	71-74	126	43,496	289.7	
	75+	101	44,695	226	
Bhopal (2012-13)	60-64	412	112,017	367.8	448.4
	65-70	341	75,228	453.3	
	71-74	322	56,214	572.8	
	75+	310	65,191	475.5	
Cachar (2012-14)	60-64	611	145,457	420.1	464.5
	65-70	455	94,857	479.7	
	71-74	374	69,937	534.8	
	75+	344	75,138	457.8	
Chennai (2012-13)	60-64	1552	348,477	445.4	562.4
	65-70	1362	221,347	615.3	
	71-74	1062	174,423	608.9	
	75+	1408	210,896	667.6	
Delhi (2012)	60-64	2822	494,626	570.5	674.6
	65-70	1942	280,365	692.7	
	71-74	1550	195,235	793.9	
	75+	1628	222,193	732.7	
Dibrugarh (2012-14)	60-64	384	113,740	337.6	389.8
	65-70	276	69,876	395	
	71-74	239	50,044	477.6	
	75+	210	52,930	396.8	
Kamrup (2012-14)	60-64	758	92,409	820.3	1048
	65-70	616	68,213	903.1	
	71-74	538	41,741	1288.9	
	75+	592	40,152	1474.4	
Kolkata (2012)	60-64	709	188,358	376.4	482.4
	65-70	650	127,574	509.5	
	71-74	559	100,282	557.4	
	75+	746	129,471	576.2	

Table 3. Continued

PBCR name	Age group	Total no of cases in each age group	Total population in each age group	Age-specific rates for each age group	Age-standardised rate for each registry
Kollam (2012-14)	60-64	1612	372,424	432.8	507.9
	65-70	1474	263,363	559.7	
	71-74	1077	192,853	558.5	
	75+	1430	271,410	526.9	
Manipur (2012-14)	60-64	550	236,102	233	319.5
	65-70	506	149,302	338.9	
	71-74	452	107,595	420.1	
	75+	557	154,225	361.2	
Meghalaya (2012-14)	60-64	532	97,313	546.7	541.4
	65-70	352	67,074	524.8	
	71-74	298	48,732	611.5	
	75+	303	62,780	482.6	
Mizoram (2012-14)	60-64	562	79,906	703.3	961.3
	65-70	504	51,689	975.1	
	71-74	439	38,312	1145.9	
	75+	661	52,182	1266.7	
Mumbai (2012)	60-64	1742	409,461	425.4	612
	65-70	1656	270,356	612.5	
	71-74	1396	192,592	724.8	
	75+	2143	246,921	867.9	
Nagaland (2012-14)	60-64	127	33,702	376.8	469.1
	65-70	122	22,791	535.3	
	71-74	82	14,922	549.5	
	75+	101	21,421	471.5	
Nagpur (2012-13)	60-64	575	170,124	338	372.9
	65-70	484	118,606	408.1	
	71-74	347	86,358	401.8	
	75+	367	102,222	359	
Naharlagun (2012-14)	60-64	195	39,591	492.5	428.9
	65-70	80	21,078	379.5	
	71-74	67	14,557	460.3	
	75+	57	16,664	342.1	
Pasighat (2012-14)	60-64	39	10,667	365.6	389.6
	65-70	29	7,152	405.5	
	71-74	23	4,938	465.8	
	75+	17	5,069	335.4	
Patiala (2012-14)	60-64	858	223,393	384.1	427.9
	65-70	669	156,035	428.7	
	71-74	484	105,673	458	
	75+	602	124,944	481.8	
Pune (2012-13)	60-64	1031	318,923	323.3	419.2
	65-70	935	208,062	449.4	
	71-74	661	142,304	464.5	
	75+	917	176,962	518.2	
Sikkim (2012-14)	60-64	149	43,228	344.7	508.8
	65-70	148	33,893	436.7	
	71-74	178	24,486	726.9	
	75+	221	30,506	724.4	

Table 3. Continued

PBCR name	Age group	Total no of cases in each age group	Total population in each age group	Age-specific rates for each age group	Age-standardised rate for each registry
Thiruvananthapuram (2012-14)	60-64	2219	470,369	471.8	581.7
	65-70	2020	338,882	596.1	
	71-74	1650	234,963	702.2	
	75+	2049	312,272	656.2	
Tripura (2012-14)	60-64	926	310,212	298.5	302
	65-70	689	224,907	306.3	
	71-74	552	161,777	341.2	
	75+	566	216,495	261.4	
Wardha (2012-14)	60-64	325	146,767	221.4	233
	65-70	337	138,036	244.1	
	71-74	262	103,983	252	
	75+	226	103,146	219.1	

inferior treatment outcomes [56, 57]. Further analyzing the consolidated regional incidence rates, South India has higher age-standardized rates than the other parts of India, an expected finding, as two of the four included Southern PBCRs are in Kerala and the other two are major cities in India. As a state, Kerala boasts higher life expectancy, the highest health index and an increased proportion of OAs (13%) [58, 59]. With the increasing availability of healthcare facilities and rising life expectancy, bigger metropolitan cities like Chennai, Mumbai, Delhi and Bengaluru have higher geriatric cancer rates, as seen in the current study. Though the PBCRs are scattered across India, most of them cover predominatly urban areas, with resultant heterogeneity in the data obtained [22]. Information on the OA cancer trends in different parts of India will help in planning national and state policies appropriately for OAs with cancer.

The current study looks at the population-based data while the hospital based data may give a different perspective on the geriatric cancer burden. In a hospital-based study from India, 28% of the total new cancer cases in a hospital occurred in OAs, with a predominance of cervical, gallbladder, laryngeal and urinary bladder cancers [60]. A report from a rural hospital registry in South India reported the common cancer sites as head and neck, lung, breast and gastrointestinal [61]. The separate analysis of each head and neck cancer subsite as per the ICD classification may also explain the lower representation of head and neck cancers in our geriatric cancer list. In a ten-year analysis from Nigeria, authors reported 33.7% geriatric cancers among the incident cancers. The common cancers were prostate, cervical, breast, colorectal and gastric cancers [62].

The PBCRs in India cover only around 10% of the total population of India, which is a significant limitation of this study [23, 30]. However, many registries are over three decades old and contribute to the international epidemiological databases. There are also strict quality assurance checkpoints to ensure adherence to the international norms for cancer registries. Without national electronic medical records, PBCR may be the richest source of information about cancer epidemiology. Also, the reported incidence rates are close to the estimated rates reported in the international study on cancers in OAs [7].

Studies on the epidemiology of geriatric cancers are essential for improving outcomes of OAs with cancer. Improvement in outcomes requires interventions at different levels. At the institute/tertiary care center levels, provision for specialized geriatric oncology clinics or at least prioritization of geriatric patients given their particular needs and mandatory inclusion of geriatric assessment reports in multidisciplinary tumor board discussions may help to improve care for OAs. Academic research institutes require allocated research funds for conducting research in OAs, a population subgroup usually excluded from most clinical trials. International and national organizations are trying to enhance knowledge and expertise among oncologists by conducting training programs and geriatric cancer workshops in conferences. Including geriatric oncology as a separate subspecialty in the curriculum of all oncology training programs may increase awareness about the needs of OA cancer patients.

There is also an unmet need for development of a framework for geriatric palliative care pathways as a significant proportion of the OA patients with cancer may have advanced disease [63]. The presence of disabling comorbidities may also preclude the patients with limited-stage cancers from curative treatment. Hence early integration of palliative care with clear documentation of goals of care and advanced care directives may help in maintenance of good quality of life and 'death with dignity' in this subset of vulnerable patients [64, 4]. The data from this study may help in planning and implementation of specialized geriatric palliative care packages, appropriate for the LMIC context, as has been developed for some specific cancers [65]. At the health policy level, creating regional geriatric centers and national centers of aging under governmental schemes like the National Policy for Senior Citizens (2011) and National Programme for Health Care of the Elderly are reasonable steps towards streamlining care for OAs [66].

Provision of special insurance schemes for OAs with coverage for appropriate cancer treatment, improved access to cancer care with outreach centers for supportive and palliative care, subsidized care for OAs and community support programs may go a long way to help the OA cancer patients. However, there is a deficiency of trained oncologists and geriatricians in India; hence, many tertiary cancer centers may not have the workforce to run a separate geriatric oncology clinic But, given that nearly 50% of the incident cancers occur in OAs, there is an urgent unmet need for expansion the cancer care of the OAs in the country. The data on geriatric cancer epidemiology will also help in national health policy planning and resource allocation for OAs, not only in India, but also other countries facing similar health care challenges like LMICs. Detailed PBCR data may not be available in other smaller countries; hence, extrapolating Indian data may help policymakers anticipate the needs of their OAs. All the stakeholders involved in geriatric cancer care need to unite and move forward to face the 'cancer tsunami' in OAs.

Author Contribution Statement

Sharada Mailankody Conceptualization, Methodology, Validation, Formal Analysis, Data Curation, Writing Original Draft, Writing- Review and Editing, Supervision . Vishwapriya Mahadev Godkhindi Conceptualization, Validation, Formal Analysis, Data Curation, Writing- Review and Editing. Karthik Udupa Conceptualization, Data Curation, Writing- Review and Editing. Ananth Pai Conceptualization, Data Curation, Writing- Review and Editing. Atul Budukh Conceptualization, Methodology, Validation, Formal Analysis, Writing- Review and Editing, Supervision. Vanita Noronha Conceptualization, Methodology, Writing- Review and Editing, Supervision. Kumar Prabhash Conceptualization,, Writing- Review and Editing, Supervision. Rajaraman Swaminathan Conceptualization, Methodology, Validation, Formal Analysis, Writing- Review and Editing, Supervision

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Ethical concerns

As it included only published deperonsalised data, ethical committee clearance was not separately obtained. The authors report no relevant conflicts of interests.

Data availability statement

The data is available on public domain as the study is derived from the published reports of the PBCRs.

Conflicts of interest

None

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