Article published online: 2025-02-04

Original Article

Epidemiology of Cancer Incidence Estimates and Statistics 2000–2025: Analysis from National Cancer Registry Programme in India

Sadanandam Vemula[1] Kalpanapriya Dhakshanamoorthy[1]

[1] Department of Mathematics, School of Advanced Sciences, Vellore Institute of Technology Vellore, Tamil Nadu, India

Ind J Med Paediatr Oncol

Address for correspondence Kalpanapriya Dhakshanamoorthy, PhD, Department of Mathematics, School of Advanced Sciences, Vellore Institute of Technology Vellore, Tamil Nadu 632014, India (e-mail: dkalpanapriya@vit.ac.in).

Abstract

Introduction Several hospital-based and population-based cancer registries (PBCRs) have been collecting cancer data systematically since 1982, according to the National Cancer Registry Programme-National Centre for Disease Informatics and Research, an initiative of the Indian Council of Medical Research.

Objective Planning, observing, and assessing cancer control efforts require knowledge of current cancer statistics. This article's goal is to provide an update on cancer incidence projections for India by age groups, sex, and anatomical sites for the period 2020 to 2025.

Materials and Methods The cancer incidence, patterns, trends, projections, and mortality from 28 PBCRs were analyzed in this study, along with the kind of therapy and stage of presentation of cancer patients from 58 HBCRs ($N = 667{,}666$) from the pooled analysis for the composite period 2012 to 2016. Data regarding the population at risk were obtained from the Indian Census (2001 and 2011) to estimate the age- and sex-stratified population. To gain a better understanding of the epidemiology of cancer, the states and areas of the nation were divided into PBCR groups.

Result For both males and females, the districts with the highest age-adjusted incidence rates were Aizawl (269.4) and Papum Pare (219.8). It is anticipated that there will be 1392,179 cancer patients in India by 2020 and 1569,793 by 2025. In Delhi, the northern region of India, the incidence rates of tobacco-related malignancies were high (62.1% for men and 18.5% for women). High incidence rates were seen in the southern districts of Kollam (males: 52.9) and Bangalore (20.1), respectively. Age-adjusted rates (AARs) for males and females in Kolkata, East, were 42.3 and 13.7, respectively. Western cities with high AARs were Mumbai (18.2) and Ahmedabad Urban (54.3) for men and women, respectively. For lung cancer, in terms of male and female incidence rates, Aizawl district ranked highest at 38.8 and 37.9 per 100,000, respectively.

Conclusion This study offers a methodology for evaluating cancer trends and status in India. To meet the national targets for noncommunicable diseases and the sustainable development goals, it will direct adequate support for action to boost efforts to promote cancer prevention and control.

Keywords

- cancer incidence
- lung cancer
- breast cancer
- tobacco-related cancer
- relative proportion

DOI https://doi.org/10.1055/s-0044-1801767.
ISSN 0971-5851.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Introduction

Nowadays, one of the main causes of sickness and death worldwide is cancer, which is also a health concern. An estimated 70% increase in cancer incidence is predicted in the next 20 years, despite continuous global efforts to prevent cancer.[1] Noncommunicable diseases (NCDs) accounted for 71% of all fatalities worldwide.[2] According to estimates, NCDs caused 63% of deaths in India, with cancer being among the top causes (9%). It is acknowledged that cancer registries are essential parts of national initiatives to manage cancer.[3] Current data on cancer incidence, trends, and projections can be found in publications from both industrialized and developing nations. Many National Cancer Registry Programme (NCRP) cancer reports from various Indian registries have been made public.[4–6] Nearly half of the world's cancer cases and over half of cancer-related deaths occur in Asian nations, according to the GLOBOCAN 2018 database.[7] Research from both domestic and international sources indicates that the Indian subcontinent has seen a marked rise in the incidence, morbidity, and death related to cancer.[8–12]

In a population that is characterized by geography, population-based cancer registries (PBCRs) offer data on the incidence and prognosis of cancer. In addition, they offer the structure for evaluating community cancer control. The main applications of HBCRs are performance reviews of clinical trials and hospital cancer programs, which deal with the documentation of data on cancer patients seen in a specific hospital. The PBCR now serves a purpose besides only providing data on the prevalence of cancer in a certain catchment region.[13] The Indian Council of Medical Research (ICMR) program report 2020 predicts that, given present trends, there will be 13.9 lakh cancer cases in the country in 2020 and that number is likely to increase to 15.7 lakh by 2025. These approximations are derived from cancer-related data gathered from 28 PBCRs. Additionally, information on cancer was provided by 58 hospital-based cancer registries (HBCRs). There will be 3.7 lakh (27.1%) tobacco-related cancer cases worldwide in 2020, according to estimates. Among women, breast cancer accounts for an estimated 2.0 lakh cases (14.8%), whereas cervical cancer accounts for 0.75 lakh occurrences (5.4%). Gastrointestinal tract malignancies account for an estimated 2.7 lakhs (19.7%) of all cancer cases, affecting both men and women. The incidence of cancer per 100,000 people in the male population varies from 269.4 in Aizawl district (the highest in India) to 39.5 in Osmanabad and Beed district. Comparably, the incidence of cancer in female populations varies from 219.8 cases per 100,000 people in the Papum Pare district to 49.4 cases in the Osmanabad and Beed areas. Roughly 94,000 new cases of cervical cancer are expected to occur annually in India alone, where it accounts for 7.92% of all malignancies diagnosed in women globally.[14,15] Breast cancer cases in Indian women have been discovered to be 10 years younger than in Western women, indicating that breast cancer develops earlier in premenopausal life in India.[16–19]

Materials and Methods

Materials

Under the ICMR-NCDIR-NCRP (ICMR-National Centre for Disease Informatics and Research-NCRP), there are now 236 HBCRs and 36 PBCRs registered. However, this article contains data from 58 HBCRs and 28 PBCRs that have at least a year's worth of high-quality data. Both during and after data submission, the registration data are subjected to multiple quality checks. These include range, consistency, and family checks in accordance with the guidelines set forth by the International Association of Cancer Registries. Both the web-based PBCR data entry application and PBCRDM 2.1 include all the checks. After the changes are received, the registry database is updated with the list of instances that may have been incorrectly sent to the relevant registries for verification using the original medical records. The NCDIR-NCRP greatly facilitates cancer registration with innovative software applications. The desktop and web-based PBCR software performs quality checks (including consistency, range, improbable, and family), matching, and duplicate checks to ensure that the data are accurate and legitimate. Furthermore, duplicate names that sound similar but have different spellings are filtered out using a phonetics program. The software is used to identify fluctuations in the number of cancer cases over time from each source of registration so that the appropriate action can be taken. When mortality data and incidence are matched, the unmatched mortality cases are classified as either death certification only or death certificate notification. After obtaining clarification from each registry at each stage, the data are finalized and ready for further analysis.

Methods

Study Design

Secondary data from HBCRs and PBCRs were used in the study.

Primary and Secondary Outcomes

This study's primary outcome is to estimate India's cancer incidence utilizing HBCRs and PBCRs. The estimation of cancer cases projected for 2025 using age-specific incidence rate is the secondary outcome.

Statistical Analysis

The following formulas are used to compute the crude incidence rate, age-specific rate (ASpR), age-standardized rate, cumulative risk, and truncated age-adjusted incidence rate for the obtained data. The statistical software Joinpoint Regression Program, Version 4.7.0, is used to analyze trends using Joinpoint models, which are regression lines that are connected at many locations. In this article, the population estimates for the years 2012 and 2016 were computed using the difference distribution method (which estimates populations by five annual age groups) using data from the censuses of 2001 and 2011. The number of cancer cases in India for 2024 was then calculated by applying the age-standardized incidence rate (ASIR) of each distinct anatomical site for the years 2012 to 2016 to the predicted population. The total estimate of all site cancer was obtained by adding the cancer estimates for each individual anatomical site (International Classification of Diseases, Tenth Revision [ICD-10]: C00–C97). Utilizing the population-weighted average of the rates from the PBCRs, the pooled age, sex, and site-specific incidence rates were calculated. The 28 PBCRs were assumed to be representative of the nation with a steady incidence rate throughout time for the purpose of estimating the incidence of cancer.

Ethical Approval

This study received ethical approval from the Institutional Ethics Committee (IEC) of the National Centre for Disease Informatics and Research (NCDIR) under reference number NCDIR/IEC/3020/2020. Participating Population-Based and Hospital-Based Cancer Registries also obtained approval from their respective Ethics Committees and secured consent from local authorities, citizen groups, and community representatives.

Crude Incidence Rate

Crude rate (CR) is the rate found by dividing the total number of cancer cases by the corresponding mid-year population estimate and then multiplying the result by 100,000.

$$CR = \frac{\text{New cases of cancer of a particular year}}{\text{Estimated population of the same year}} * 100{,}000.$$

Age-Specific Rate

ASpR is the rate determined by dividing the total number of cancer cases by the estimated population in that age group, gender, site, geographic area, and time, then multiplying the result by 100,000.

$$ASpR = \frac{\text{New cases of cancer of a particular year in the given age group}}{\text{Estimated population of the same year for the given age group}} * 100{,}000$$

Age-Standardized Rate

Cancer incidence increases as age increases. Accordingly, the number of cancer cases increases with the percentage of the population that is older. The proportion of older people is higher in most developed and Western countries. Hence, age-adjusted rate (AAR) or age-standardized rate are calculated using a world standard population that accounts for this to make cancer rates comparable between nations. By collecting the ASpRs and applying them to the standard population in that age group, this is estimated using the direct technique[20] (Boyle and Parkin, 1991).

$$AAR = \frac{\sum(\text{ASpR}) \times (\text{No.of persons in Std.world population in that 5 yearage group})}{100{,}000}$$

Cumulative Risk

The probability that a person would acquire a specific cancer at a given age, barring any other cause of death, is known as cumulative risk. An approximation of the cumulative risk is the cumulative rate (CuR). It is calculated by multiplying the yearly age-specific incidence rates by 5 (the 5-year age interval), times 100/100,000. This process is repeated for each 5-year age interval, up to 64 or 74 years of age, or for whatever age group is to be used to compute the cumulative risk.

$$CuR = \frac{5 * \sum(\text{ASpR}) * 100}{100{,}000}$$

Truncated Age-Adjusted Incidence Rate

This is similar to the age-adjusted rate, with the exception that it is based on a reduced age range of 35 to 64.

Results

Calculation of Cancer Incidence

The number of men and women covered by PBCRs is provided using data from 32 geographic locations. There are 865 girls for every 1,000 males in Mumbai PBCR, which has the lowest sex ratio in the data. In comparison to other PBCRs, the percentage of rural residents reporting was higher in the northeastern (NE) PBCRs. There are 12 pure urban PBCRs, 1 pure rural PBCR, and 15 PBCRs that cover the populations of both urban and rural areas in varying percentages. ►**Table 1** shows that the top five PBCRs with the highest number of cases registered were Thiruvananthapuram district (27,833), Bangalore (29,049), Chennai (31,271), Delhi (60,097), and Mumbai (53,714). With the exception of Manipur, Imphal West district, and Papum Pare district in Arunachal Pradesh, the majority of registries in the NE region of the country showed a greater percentage of cancer cases in men. Except for Delhi, the Kollam district, Kolkata, and Ahmedabad urban, there were more female cancer cases reported in other places.

Crude Rate

According to ►**Table 2**, Aizawl district (206.2) has the highest CR per 100,000 men, followed by Mizoram state (146.1), Kollam district (159.4), Kamrup urban (190.5), and Thiruvananthapuram district (170.4). Similarly, the district with the highest CR for females is Aizawl (174.6), followed by Kollam (139.1), Chennai (141.4), Kamrup urban (150.8), and Thiruvananthapuram (164.8). Greater crude incidence rates in both males and females have been reported by the registries covering the country's NE and southwest coastal regions.

Age-Adjusted Rates

Osmanabad and Beed in Maharashtra have an AAR of 369.5, whereas Aizawl in the state of Mizoram has an AAR of 269.4. East Khasi Hills in Meghalaya has an AAR of 227.9. Under the West Arunachal PBCR, the female population varied from 49.4 in the Osmanabad and Beed districts to 219.8 in the Papum Pare district, with Aizawl district coming in second at 214.1.

Truncated Rates

Between Osmanabad and Beed district (71.5) and East Khasi Hills district (494.5), there was a variation in the truncated rate (TR) per 100,000 population for men; Aizawl district came in second with 485.5. The range for females was

Table 1 Total number of cancer cases registered in 28 PBCRs under NCRP

S. No	Registry	Males		Females		Total
NORTH						
		n	%	*n*	%	*N*
1	Delhi (2012–14)	31,032	51.6	29,065	48.4	60,097
2	Patiala (2012–16)	5,394	47.0	6,077	53	11,471
SOUTH						
3	Hyderabad (2012–14)	5,143	44.4	6,453	55.6	11,596
4	Kollam (2012–16)	9,930	50.4	9,780	49.6	19,710
5	Thiruvananthapuram (2012–16)	13,506	48.5	14,327	51.5	27,833
6	Bangalore (2012–14)	13,221	45.5	15,828	54.5	29,049
7	Chennai (2012–14)	14,468	46.3	16,803	53.7	31,271
EAST						
8	Kolkata (2012–2015)	10,186	52.7	9,151	47.3	19,337
WEST						
9	Ahmedabad urban (2012–2016)	14,579	56.9	11,025	43.1	25,604
10	Aurangabad (2012–2016)	1,923	49.0	2,001	51.0	3,924
11	Osmanabad and Beed (2012–2015)	3,635	44.9	4,467	55.1	8,102
12	Barshi rural (2012–2016)	726	47.2	813	52.8	1,539
13	Mumbai (2012–2015)	26,256	48.9	27,458	51.1	53,714
14	Pune (2012–2016)	9,687	47.2	10,818	52.8	20,505
CENTRAL						
15	Wardha district (2012–2016)	2,389	48.5	2,537	51.5	4,926
16	Bhopal (2012–2015)	3,567	49.8	3,589	50.2	7,156
17	Nagpur (2012–2016)	5,952	49.6	6,047	50.4	11,999
NORTHEAST						
18	Manipur state (2012–2016)	3,702	45.1	4,500	54.9	8,202
19	Mizoram state (2012–2016)	4,323	53.6	3,736	46.4	8,059
20	Sikkim state (2012–2016)	1,172	50.9	1,131	49.1	2,303
21	Tripura state (2012–2016)	6,559	57.2	4,914	42.8	11,473
22	West Arunachal (2012–2016)	1,222	51.1	1,171	48.9	2,393
23	Meghalaya (2012–2016)	4,688	62.3	2,832	37.7	7,520
24	Nagaland (2012–2016)	1,403	58.6	992	41.4	2,395
25	Pasighat (2012–2016)	321	51.4	303	48.6	624
26	Cachar district (2012–2016)	4,663	54.2	3,943	45.8	8,606
27	Dibrugarh district (2012–2016	2,535	53.1	2,238	46.9	4,773
28	Kamrup urban (2012–2016)	6,223	56.5	4,790	43.5	11,013

Abbreviations: *n*, number of cancer cases, males or females; *N*, total number of cancer cases; NCRP, National Cancer Registry Programme; PBCR, population-based cancer registry.

likewise 108.2 in the Osmanabad and Beed districts to 499.0 in the Papum Pare, Arunachal Pradesh area.

The estimated top sites of cancer cases by time periods (2015, 2020, and 2025) are shown in ►**Table 3**. All-site cancers in females are expected to rise to 806,218 in 2025 from 627,202 in 2015, whereas in males they are expected to rise to 763,575 in 2025 from 601,737 in 2015. As of 2025, the number of males and females with anticipated leading cases of lung and breast cancer, respectively, would be 81,219 and 232,832 accordingly. Between 2015 and 2025, there is projected to be a 27.7% increase in cancer cases across all sites combined.

The top five cancer sites in men expected in the year 2024 are the mouth (8.9%), tongue (6.3%), stomach (5.2%), prostate (6.5%), and lung (11%). They are also shown in ►**Figs. 1** and **2**. Breast (30.1%), cervix (11.2%), ovary (6.6%), corpus uteri (4.1%), and lung (4%) were the estimated top five sites of cancer in women. Males were more likely to have liver cancer

Table 2 Incidence rates: CR, AAR, and TR (35–64 years) per 100,000 population for all sites of cancer in 28 PBCRs under NCRP

S. No	Registry	Males			Females		
		CR	ARR	TR	CR	ARR	TR
NORTH							
1	Delhi (2012–2014)	112.3	147.0	232.2	119.6	141.0	279.0
2	Patiala district (2012–2016)	101.6	108.2	196.4	127.7	124.6	271.4
SOUTH							
3	Hyderabad district (2014–2016)	84.2	101.6	172.2	109.8	136.0	278.3
4	Kollam district (2012–2016)	159.4	127.7	198.0	139.1	107.1	205.7
5	Thiruvananthapuram district (2012–2016)	170.4	137.8	211.5	164.8	127.3	242.8
6	Bangalore (2012–2014)	96.8	122.1	181.7	125.1	146.8	283.6
7	Chennai (2012–2016)	121.8	119.9	185.2	141.4	132.8	260.5
EAST							
8	Kolkata (2012–2015)	109.9	91.2	145.2	105.9	89.2	175.9
WEST							
9	Ahmedabad urban (2012–2016)	89.1	98.3	183.2	74.7	76.7	158.0
10	Aurangabad (2012–2016)	56.6	70.9	121.6	62.9	75.1	158.5
11	Osmanabad and Beed (2012–2015)	39.3	39.5	71.5	52.8	49.4	108.2
12	Barshi rural (2012–2016)	53.9	50.6	80.5	67.2	61.0	126.5
13	Mumbai (2012–2015)	97.3	108.4	155.1	117.6	116.2	207.6
14	Pune (2012–2016)	67.5	83.0	120.0	83.3	94.0	177.7
CENTRAL							
15	Wardha district (2012–2016)	70.4	64.5	109.7	78.7	69.9	148.9
16	Bhopal (2012–2015)	83.3	101.0	180.0	90.4	106.9	223.3
17	Nagpur (2012–2016)	89.0	91.1	158.6	93.1	89.8	188.2
NORTHEAST							
18	Manipur state (2012–2016)	47.0	62.8	91.0	57.8	71.1	129.6
19	Mizoram state (2012–2016)	146.1	207.0	357.7	127.5	172.3	313.2
20	Sikkim state (2012–2016)	69.9	88.7	131.5	75.3	97.0	175.2
21	Tripura state (2012–2016)	67.0	80.9	145.9	52.0	58.3	127.3
22	West Arunachal (2012–2016)	56.6	101.1	199.9	56.3	96.3	215.7
23	Meghalaya (2012–2016)	92.6	176.8	386.0	55.7	96.5	201.1
24	Nagaland (2012–2016)	74.5	124.5	223.8	56.3	88.2	193.6
25	Pasighat (2012–2016)	90.7	120.4	207.6	88.1	116.2	260.3
26	Cachar district (2012–2016)	99.2	129.0	233.4	87.0	104.8	234.2
27	Dibrugarh district (2012–2016)	72.5	91.9	155.9	66.0	76.8	170.7
28	Kamrup urban (2012–2016)	190.5	213.0	339.7	150.8	169.6	320.8

Abbreviations: ARR, age-adjusted rate; CR, crude rate; NCRP, National Cancer Registry Programme; PBCR, population-based cancer registry; TR, truncated rate.

(4.2%) among the top 10 cancers than females, whereas females were more likely to have thyroid (3.8%) and gallbladder (3%) cancers.

According to age group (0–14, 15–39, 40–64, and 65 +), ►**Table 4** presents the predicted top five sites of cancer (%) in India by gender for the year 2024. Lymphoid leukemia is the most common site in the childhood (0–14 years) group for both boys (29.06%) and girls (24.07%). Boys' brain nerve systems (NSs) come in second with 12.6% and girls' 14.17%, respectively. For males, in the 15- to 39-year-old age group, the most common sites are the mouth (12.6%), tongue (9.53%), brain NS (7.4%), myeloid leukemia (6.72%), and non-Hodgkin lymphoma (6.23%); for females, the most common sites are the breast (27.05%), thyroid (13.07), ovary (7.82%), cervix (6.69%), and myeloid leukemia (3.56%). The mouth (11.08%), tongue (7.52%), and lung (11.0%) were the most common sites among males in the 40 to 64 age group. The most common sites in females were the breast (32.3%),

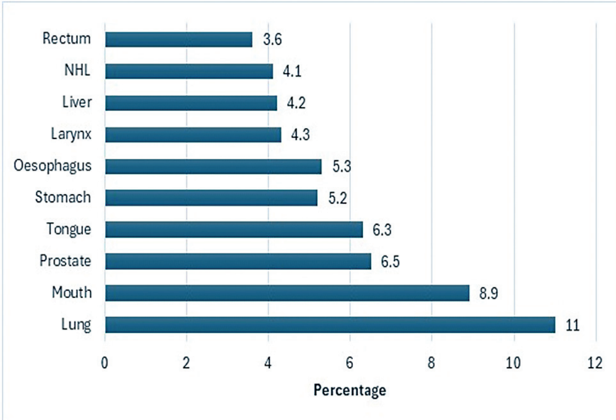

Fig. 1 Estimated proportion of top 10 leading sites of cancer in India by sex, males 2024.

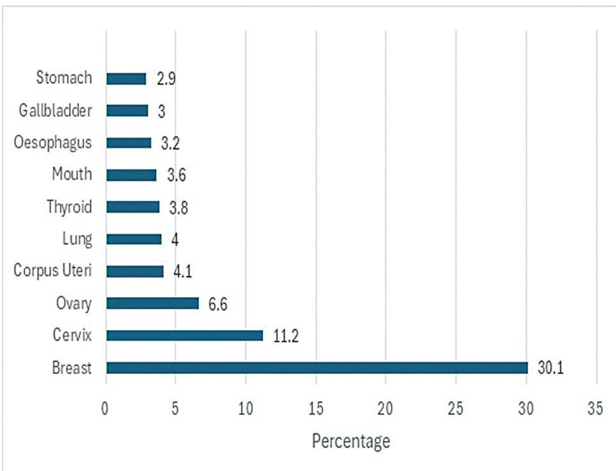

Fig. 2 Estimated proportion of top 10 leading sites of cancer in India by sex, females 2024.

cervix (12.2%), and ovary (6.70%); there were high incidence of cases in this age range in both males (350,141) and females (439,960). In men over 65 years, the prostate (11.9%) was the second most common site after the lung (12.90%). Lung cancer was the most prevalent cancer in men over 40 years, while breast cancer was the most common in women.

►**Supplementary Fig. S1** (online only) shows India's projected ASIR and number of cancer patients by gender and age group over a 5-year period in 2024. In both males and females, the ASIR for all cancer sites began to rise at age 25. The ASIR was higher in females than in males between the ages of 25 and 59 years. The ASIR for males was higher than that of females above the age of 60, peaking at 710.8 per 100,000 at 75 years or older. In contrast, the ASIR fell to 452.7 per 100,000 in females aged 75 year and above. The age group of 60 to 64 years old had the greatest number of cancer cases (105,561 female cases and 106,542 male cases).

The Relative Proportion of Cancer Cases Across All Sites in Hospital-Based Cancer Registries

A total of 58 HBCR centers that have successfully finished data transmission and quality checks for 1 or more years between 2012 and 2016 were chosen for inclusion in the study out of the 236 HBCR centers registered with NCRP. Several of these hospitals' data (42 out of 58) are included in the NCDIR-NCRP network for the first time. The analysis excludes the remaining HBCRs due to insufficient data. According to pooled data from 58 HBCRs, the number and relative proportion of patients by treatment types, educational attainment, and clinical severity of disease at the time of diagnosis are shown for a few selected locations. The reporting institute (RI) has exclusively treated cases; instances that were previously processed outside of RI have not been analyzed. In relation to all instances of cancer with microscopically diagnosed tumors, the major histologic type (according to the World Health Organization categorization of tumors) and its relative proportion have been described for the 58 HBCRs in this study. Males made up 52.9% and females made up 47.1% of the 667,666 cases that were registered. Male and female cancer patients at Tata Memorial Hospital in Mumbai accounted for the greatest number of newly reported cases across all cancer sites. The relative proportion and new cases reported for all sites of cancer in 58 HBCRs is provided in ►**Supplementary Table S1** (online only).

Table 3 Estimated trends in number of cancers for the leading sites (ICD-10 codes) in India (2015, 2020, and 2025)

Males				Females			
Cancer site (ICD 10)	2015	2020	2025	Cancer site (ICD 10)	2015	2020	2025
Lung (C33–34)	63,087	71,788	81,219	Breast (C50)	180,252	205,424	232,832
Mouth (C03–C06)	50,779	57,380	64,519	Cervix (C53)	65,978	75,209	85,241
Prostate (C61)	36,419	41,532	47,068	Ovary (C56)	38,607	43,886	49,644
Tongue (C01–C02)	35,336	39,902	44,861	Corpus uteri (C54)	23,175	26,514	30,121
Stomach (C16)	28,815	32,713	36,938	Lung (C33–34)	23,163	26,490	30,109
Others	387,301	436,106	488,970	Others	296,027	335,235	378,271
All sites	**601,737**	**679,421**	**763,575**	**All sites**	**627,202**	**712,758**	**806,218**

Abbreviation: ICD-10, International Classification of Diseases, Tenth Revision.

Table 4 The estimated top five leading sites of cancer (number and proportion) in India by age group (0–14, 15–39, 40–64, and 65+ age groups) and sex for the year 2024

Males			Females
Cancer site	*n* (%)	Cancer site	*n* (%)
0–14 years			
Lymphoid leukemia (C91)	6,365 (29.06)	Lymphoid leukemia (C91)	3,568 (24.07)
Brain and NS (C70–C72)	2,740 (12.6)	Brain and NS (C70–C72)	2,100 (14.17)
NHL (C82–86, C96)	1,720 (7.6)	Bone (C40–C41)	1,226 (8.27)
Hodgkin's disease (C81)	1,624 (7.6)	Myeloid leukemia (C92–C94)	1,270 (8.56)
Myeloid leukemia (C92–C94)	1,601 (7.31)	NHL (C82–86, C96)	953 (6.42)
Other sites	7,848 (36)	Other sites	5,705 (38.5)
All sites	**21,898 (100)**	**All sites**	**14,822 (100)**
15–39 years			
Mouth (C03–C06)	10,122 (12.60)	Breast (C50)	27,562 (27.05)
Tongue (C01–C02)	7,652 (9.53)	Thyroid (C73)	13,324 (13.07)
Brain and NS (C70–C72)	5,923 (7.4)	Ovary (C56)	7,966 (7.82)
Myeloid leukemia (C92–C94)	5,400 (6.72)	Cervix (C53)	6,821 (6.69)
NHL (C82–86, C96)	5,012 (6.23)	Myeloid leukemia (C92–C94)	3,625 (3.56)
Other sites	46,216 (57.5)	Other sites	42,568 (41.8)
All sites	**80,325 (100)**	**All sites**	**101,866 (100)**
40–64 years			
Lung (C33–34)	38,537 (11.0)	Breast (C50)	142,124 (32.3)
Mouth (C03–C06)	38,800 (11.08)	Cervix (C53)	53,687 (12.20)
Tongue (C01–C02)	26,354 (7.52)	Ovary (C56)	29,514 (6.70)
Esophagus (C15)	19,964 (5.7)	Corpus uteri (C54)	20,142 (4.6)
Stomach (C16)	19,231 (5.5)	Lung (C33–34)	15,841 (3.60)
Other sites	207,254 (59.19)	Other sites	178,652 (40.6)
All sites	**350,141 (100)**	**All sites**	**439,960 (100)**
65+ years			
Lung (C33–34)	37,600 (12.90)	Breast (C50)	51,123 (22.7)
Prostate (C61)	34,562 (11.9)	Cervix (C53)	21,134 (9.4)
Esophagus (C15)	15,963 (5.5)	Lung (C33–34)	13,258 (5.9)
Stomach (C16)	15,623 (5.3)	Ovary (C56)	13,245 (5.87)
Mouth (C03–C06)	15,784 (5.40)	Mouth (C03–C06)	10,246 (4.54)
Other sites	172,231 (59.0)	Other sites	116,258 (51.6)
All sites	**291,763 (100)**	**All sites**	**225,264 (100)**

Abbreviations: NHL, non-Hodgkin lymphoma; NS, nervous system.

Cancer Associated with Tobacco in Males and Females

It is established that tobacco use is linked to malignancies in several anatomical locations. The World Health Organization's monographs on general assessments of carcinogenicity, published by the International Agency for Research on Cancer (IARC) in 1987, have been the basis for the NCRP's classification system. More anatomical sites discussing the connection between tobacco use and cancer have been added to the most current IARC monographs. The following regions are used to group the data from all 58 HBCRs: North, South, East, West, Central, and North East. This is performed irrespective of the patient's residency status.

With a cancer incidence rate of 70.4% in men and 46.5% in women, the East Khasi Hills district of Meghalaya has the greatest relative proportion of malignancies linked to tobacco smoking. Thiruvananthapuram district had the lowest number of cancer sites associated with tobacco use (10.1%) among females, while West Arunachal had the lowest percentage among males (24.5%). The NE states of India had the highest percentage of female smokers with cancer, followed by the central and western regions of India with the highest number of registries. The relative proportion of specific sites of cancer associated with the use of tobacco by region is mentioned in ►**Supplementary Table S2** (online only).

Lung Cancer

The incidence rates of lung cancer in both males and females in the PBCRs of Bangalore, Delhi, Chennai, and Kamrup urban have significantly increased. In contrast to the 11 PBCRs involving females, 5 PBCRs involving males showed a statistically significant rise in incidence rates. In terms of male and female incidence rates, Aizawl district ranked highest at 38.8 and 37.9 per 100,000, respectively. Data on the overall number of lung cancer cases that have been reported, together with the disease's relative proportion and incidence rates, are included in ►**Supplementary Tables S3** and **S4** (online only).

Lung cancer rates among nonsmokers are increasing, and significant contributing factors are radon gas, indoor smoke from solid fuels, outdoor air pollution, and hazardous dust exposure. Other notable concerns include genetic predisposition and passive smoking. Preventive measures such as promoting smoke-free environments, improving indoor ventilation, and reducing air pollution can play a vital role in mitigating these risks.

Discussion

Cancer is not homogeneous in India. For both males and females, the incidence rates in Aizawl district were found to be seven times and four times higher, respectively, than those in Osmanabad and Beed district PBCRs. Compared with other parts of the nation, the NE region had the highest cancer incidence rate (six PBCRs for males and four PBCRs for females). Cancer was most common in the NE region in the following areas: stomach, liver, gallbladder, esophagus, nasopharynx, hypopharynx, cervix uteri, lung, and breast. The low 5-year survival rates of head and neck, breast, and cervical cancer in comparison to the rest of India indicate that the NE region lacks the necessary infrastructure in terms of specialist treatment facilities and human resources. A significant percentage of cancer patients from the NE region go outside of the region for their care. As shown in Thailand, the variety in cancer incidence pattern and variances in India may have been influenced by local cultural variables and lifestyle choices.

The most prevalent malignancies in men were those of the lung (9 PBCRs), mouth (9 PBCRs), esophagus (5 PBCRs), stomach (4 PBCRs), and nasopharynx (1 PBCR). The most common cancer in urban areas and the south was lung cancer, whereas the most common cancer in the west and central regions was mouth cancer. The most prevalent malignancies among men in the Indian subcontinent were lung and mouth cancers. Most cases in the NE part of India were stomach, nasopharyngeal, and esophageal cancers. Compared with the rest of India, this region has a different cancer incidence pattern. The cancer incidence pattern is comparable to that of Southeast Asia. All things considered, these cancer pattern findings aligned with previously released data under NCRP.

The hospital database was employed for this type of study since it is challenging to extract data from PBCRs regarding the clinical severity of the illness and its course of treatment. Most cases of cervix uteri and breast cancer were discovered after they were already locally progressed. The standard treatment for cervical cancer in locally advanced or metastatic stages is a combination of chemotherapy and radiation. Additionally, vascular endothelial growth factor inhibitors and immunotherapy have enhanced treatment options, providing a more comprehensive approach to managing the disease. In India, a multi-institutional study on cervix cancer revealed that, in the locally advanced stage, chemotherapy and radiation proved to be substantially more effective in survival than radiation therapy alone. Concurrent chemoradiation for locally advanced cervical cancer produced the best disease-free survival, according to a study from Chennai. When it came to head and neck malignancies from HBCRs, two-thirds of the patients had a locoregional cancer diagnosis. The data from Uttarakhand reveal a concerning trend in the diagnosis of head and neck cancer, with most patients (88.1%) presenting at advanced stages. This suggests that early detection methods are insufficient, highlighting the need for more effective screening programs and public awareness initiatives. The fact that only 8.5% of patients are diagnosed in the early stages points to a significant gap in health care practices, which could lead to worse outcomes for patients. To address this issue, focused efforts are required to raise awareness, enhance detection capabilities, and implement region-specific strategies for early diagnosis and intervention. This is particularly crucial in areas with high incidence rates of head and neck cancers, where timely treatment can significantly improve survival rates. According to an estimate from a multi-institutional study, poor survival occurred in 65% of newly diagnosed head and neck malignancies with locally advanced disease because they did not receive the best possible care.

The lack of notification for cancer makes it difficult to register cases in India and makes data collection more difficult.[21–24] The anticipated cancer burden in India for 2001 was derived from the data obtained from the three PBCRs.[25] Updates to cancer estimates were released based on PBCRs that were available as a result of their expansion.[26–29] Recently, GLOBOCAN estimated the cancer incidence in India for 2020 using data from 27 PBCRs from 2012 to 2014 and the ASIR, which estimates cancer incidence across five continents.[30,31] Based on the assumption that the ASIR in 2020 would remain unchanged, China predicted the incidence for the year 2022.[32] There are various flaws in the mortality registration system, one of which is the erroneous and incomplete certification of the reason for death.[33,34] A framework for evaluating India's cancer trends and status is provided by this research. As a result, the national NCD targets and the sustainable development goals will be met, and work to promote cancer prevention and control will receive the proper support.[8,35]

Breast cancer is the leading cancer in women, with family history being a key risk factor. Women with close relatives who had breast cancer, especially at a young age, are at higher risk. Genetic testing can identify mutations in genes like BRCA1 and BRCA2, which significantly increase the risk of breast and ovarian cancers. Other genetic mutations, such as in PALB2 and CHEK2, can also raise risk. Genetic testing helps guide preventive measures and informed health decisions, though not all cases are hereditary. Family history and genetic testing are valuable for assessing risk and prevention.

Adolescent human papillomavirus (HPV) vaccination helps prevent cervical cancer by focusing on the virus that causes the disease. Early screening for women, such as Pap smears and HPV tests, can detect precancerous alterations in the cervix. Early treatment is possible with the timely discovery of these lesions, which lowers the risk of malignancy. Implementing screening and immunization initiatives can significantly reduce the incidence of cervical cancer. These preventive approaches decrease the burden of cervical cancer and improve overall health outcomes.

In conclusion, India's cancer incidence burden is still rising. Breast cancer ranked highest among the five most common cancers in women, followed by cancers of the cervix, ovary, and corpus uteri. Three sites were restricted to tobacco-related malignancies in males: the tongue, mouth, and lungs. To lessen the burden of cancer in the future, a preventative action must be performed. The updated estimates are beneficial for early diagnosis, risk reduction, and management initiatives related to cancer prevention and control in India. To go further into the causes of the cancer burden and offer practical remedies, however, appropriate research is required.

Limitations of the Study

There are several challenges to be addressed while registering a case in India to gather data, as cancer is not a disease that needs to be reported. Because of limits in the number of deaths from cancer, mortality data were incomplete due to inadequate coverage of the Civil Registration System. Accurate death statistics have proven difficult to obtain, and the quality of the data differs throughout PBCRs. As a result, no attempt was made to estimate incidence from death or survival. Statistical modeling techniques like age–period–cohort could not be included because most of the PBCRs did not have longer data periods available. In low- and middle-income nations, launching a PBCR presented several difficulties. For the goal of cancer control, a sample of regional PBCRs or a group of regional PBCRs with 10% of coverage would be very beneficial. This is the finest cancer data available in the nation for estimation under these circumstances. The burden estimates for India and a few of the neighboring nations in South Asia have been derived from GLOBOCAN and IARC using the identical PBCRs. In India, cancer incidence might be better covered with fewer resources if health care providers registered through passive notification. For the smooth enhancement of cancer statistics, cancer registries must be connected to many national and local databases (Ayushman Bharat, other insurance programs, mortality databases, Health Management Information System, etc.).

Conclusion

The NE region of India had the highest cancer incidence recorded. The most prevalent malignancies in men were those of the mouth, throat, stomach, and esophagus. The most prevalent malignancies in women were cervix uteri and breast cancer. Oropharyngeal, nasopharyngeal, hypopharyngeal, esophageal, stomach, liver, gall bladder, larynx, lung, and cervix uteri cancers had the highest cancer burden in the NE. For stomach and lung cancer, systemic therapy was the most often used form of treatment. In the world, people over 65 years account for half of all cancer cases, while in India, the proportion is one-third. In India, however, the 40- to 64-year-old age group accounts for half of the estimated cancer burden. According to estimates, the incidence of cancer cases will rise from 2.8% in 2020 to 12.8% in 2025. By 2025, 29.8 million disability-adjusted life years are expected to be caused by cancer in India, according to a recent NCRP study. The burden of cancer in the future must be decreased by taking a preventative action. When it comes to early detection, risk reduction, and management initiatives aimed at controlling cancer in India, the updated estimations are beneficial. But to address the causes of the cancer burden and offer practical remedies, adequate research is required.

Funding
None.

Conflict of Interest
None declared.

References

1 Tyagi BB, Bhardwaj NK, Raina V. Time trends of cancer in a tertiary care centre 2013–2017. Int J Med Health Res 2019;5(11):152–158
2 World Health Organization. World health statistics. 2019: monitoring health for the SDGs, sustainable development goals. Published online 2019. Accessed December 23, 2024 at: https://www.who.int/publications/i/item/9789241565707
3 Parkin DM. The evolution of the population-based cancer registry. Nat Rev Cancer 2006;6(08):603–612
4 National Centre for Disease Informatics and Research. Consolidated Report of Population Based Cancer Registries, 2006–2008, 2009–2011, 2012–2014 Bengaluru, India, National Cancer Registry Programme. Accessed December 23, 2024 at: https://ncdirindia.org/Reports.aspx
5 National Centre for Disease Informatics and Research. Time trends in cancer incidence rates, 1982–2010, Bangalore: National Cancer Registry Programme (NCRP-ICMR),. 2013. Accessed December 23, 2024 at: https://www.ncdirindia.org/All_Reports/TREND_REPORT_1982_2010/
6 Office of the Registrar General & Census Commissioner. India. Population in Five-Year Age Group by Residence and Sex. New Delhi (India); 2011. Accessed May 20, 2023 at: https://censusindia.gov.in/nada/index.php/catalog/1541
7 Office of the Registrar General & Census Commissioner India. Census of India Website. Censusindia.gov.in. Published 2011 at: http://www.censusindia.gov.in/census.website
8 Babu GR, Lakshmi SB, Thiyagarajan JA. Epidemiological correlates of breast cancer in South India. Asian Pac J Cancer Prev 2013;14 (09):5077–5083
9 Thangjam S, Laishram RS, Debnath K. Breast carcinoma in young females below the age of 40 years: a histopathological perspective. South Asian J Cancer 2014;3(02):97–100

10 Jonnada PK, Sushma C, Karyampudi M, Dharanikota A. Prevalence of molecular subtypes of breast cancer in India: a systematic review and meta-analysis. Indian J Surg Oncol 2021;12(Suppl 1):152–163
11 Ali I, Wani WA, Saleem K. Cancer scenario in India with future perspectives. Cancer Ther 2011;8:56–70
12 Srinath Reddy K, Shah B, Varghese C, Ramadoss A. Responding to the threat of chronic diseases in India. Lancet 2005;366(9498): 1744–1749
13 Mathur P, Sathishkumar K, Chaturvedi M, et al; ICMR-NCDIR-NCRP Investigator Group. Cancer Statistics, 2020: report from National Cancer Registry Programme, India. JCO Glob Oncol 2020; 6(06):1063–1075
14 Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A. Global cancer statistics, 2012. CA Cancer J Clin 2015;65(02):87–108
15 Time Trends in Cancer Incidence Rates 1982–2010. Accessed December 23, 2024 at: https://www.ncdirindia.org/All_Reports/TREND_REPORT_1982_2010/
16 Balasubramaniam SM, Rotti SB, Vivekanandam S. Risk factors of female breast carcinoma: a case control study at Puducherry. Indian J Cancer 2013;50(01):65–70
17 Chopra B, Kaur V, Singh K, Verma M, Singh S, Singh A. Age shift: breast cancer is occurring in younger age groups - Is it true? Clin Cancer Investig J 2014;3(06):526–529
18 Sandhu DS, Sandhu S, Karwasra RK, Marwah S. Profile of breast cancer patients at a tertiary care hospital in north India. Indian J Cancer 2010;47(01):16–22
19 Kakarala M, Rozek L, Cote M, Liyanage S, Brenner DE. Breast cancer histology and receptor status characterization in Asian Indian and Pakistani women in the U.S.–a SEER analysis. BMC Cancer 2010; 10:191
20 Boyle P, Parkin, D.M. Statistical methods for registries. In D.M. Parkin, C. S. Muir, S. L.Whelan, Y. T.Gao, J. Ferlay, J. Powell, (Eds.), Cancer Incidence in Five Continents, Volume VI. IARC Scientific Publications No. 120:126–158
21 Bray F, Znaor A, Cueva P, et al. Planning and Developing Population-Based Cancer Registration in Low- or Middle-Income Settings. Lyon, France: International Agency for Research on Cancer; 2014
22 Dhar M. A critical review of evolution of cancer registration in India. J Tumor Med Prev 2018;2(04):555594
23 Sahoo S, Verma M, Parija P. An overview of cancer registration in India: present status and future challenges. Oncol J India 2018;2 (04):86
24 Behera P, Patro BK. Population Based Cancer Registry of India – the challenges and opportunities. Asian Pac J Cancer Prev 2018;19 (10):2885–2889
25 Murthy NS, Juneja A, Sehgal A, Prabhakar AK, Luthra UK. Cancer projection by the turn of century-Indian science. Indian J Cancer 1990;27(02):74–82
26 Murthy NS, Chaudhry K, Rath GK. Burden of cancer and projections for 2016, Indian scenario: gaps in the availability of radiotherapy treatment facilities. Asian Pac J Cancer Prev 2008;9(04): 671–677
27 Swaminathan R, Shanta V, Ferlay J, Balasubramanian S, Bray F, Sankaranarayanan 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(02):72–77
28 Takiar R, Nadayil D, Nandakumar A. Projections of number of cancer cases in India (2010-2020) by cancer groups. Asian Pac J Cancer Prev 2010;11(04):1045–1049
29 D'Souza NDR, Murthy NS, Aras RY. Projection of cancer incident cases for India -till 2026. Asian Pac J Cancer Prev 2013;14(07): 4379–4386
30 Kamangar F, Dores GM, Anderson WF. Patterns of cancer incidence, mortality, and prevalence across five continents: defining priorities to reduce cancer disparities in different geographic regions of the world. J Clin Oncol 2006;24(14):2137–2150
31 Ferlay J, Colombet M, Soerjomataram I, et al. Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods. Int J Cancer 2019;144(08):1941–1953
32 Xia C, Dong X, Li H, et al. Cancer statistics in China and United States, 2022: profiles, trends, and determinants. Chin Med J (Engl) 2022;135(05):584–590
33 Kakkar R, Aggarwal P. Civil registration and sample registration system: challenges and initiatives. SRHU Med J 2017;1(01):47–49
34 Porter PL. Global trends in breast cancer incidence and mortality. Salud Publica Mex 2009;51(Suppl 2):s141–s146
35 Kishore S, Kiran K. Cancer scenario in India and its comparison with rest of the world and future perspectives. Indian J Community Health 2019;31(01):1–3

