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Cancer incidence estimates for 2022 & projection for 2025: Result from National Cancer Registry Programme, India

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***Background & objectives*: Information on recent cancer statistics is important for planning, monitoring and evaluating cancer control activities. This article aims to provide an update on the cancer incidence estimates in India by sex, age groups and anatomical sites for the year 2022.**

***Methods*: The National Cancer Registry Programme Report 2020, reported the cancer incidence from 28 Population-Based Cancer Registries (PBCRs) for the years 2012-2016. This was used as the basis to calculate cancer estimates in India. Information pertaining to the population at risk was extracted from the Census of India (2001 and 2011) for the estimation of age–sex stratified population. PBCRs were categorised into the respective State and regions of the country to understand the epidemiology of cancer. The age-specific incidence rate for each specific anatomical site of cancer was applied to the estimated population to derive the number of cancer cases in India for 2022.**

***Results*: The estimated number of incident cases of cancer in India for the year 2022 was found to be 14,61,427 (crude rate:100.4 per 100,000). In India, one in nine people are likely to develop cancer in his/her lifetime. Lung and breast cancers were the leading sites of cancer in males and females, respectively. Among the childhood (0-14 yr) cancers, lymphoid leukaemia (boys: 29.2% and girls: 24.2%) was the leading site. The incidence of cancer cases is estimated to increase by 12.8 per cent in 2025 as compared to 2020.**

***Interpretation & conclusions*: The cancer incidence is continuing to increase in India. The new estimates will be helpful in planning cancer prevention and control activities through the intervention of early detection, risk reduction and management.**

Key words Cancer - estimates - incidence - India - National Cancer Registry Programme - projection

According to the Global Cancer Observatory (GLOBOCAN) estimates, there were 19.3 million incident cancer cases worldwide for the year 2020[1]. India ranked third after China and the United States of America[2]. GLOBOCAN predicted that cancer cases in India would increase to 2.08 million, accounting for a rise of 57.5 per cent in 2040 from 2020[2].

Planning, monitoring and evaluation of cancer control activities requires recent statistics in any region. This is usually achieved through the Population-Based

Cancer Registries (PBCRs). Cancer is not a nationally notable disease in India. Thus, the data collection from PBCRs involves active retrospective data abstraction, laborious and a complex process of analysis and reporting. Trained registry staff typically go to different resource centers (hospitals, vital statistics departments and diagnostic laboratories) for collecting data on a standardized core form[3]. This delays the process of real-time reporting and bringing out the most recent cancer statistics. Globally, there is usually a lag of 2-4 yr between actual cancer registry data and the publication of results (*e.g*. US cancer registry, GLOBOCAN)[3,4]. Thus, providing estimates at periodic intervals is the best way for informing cancer prevention and control programmes. Hence, efforts to provide timely cancer estimates based on the recently available data for formulating appropriate cancer control measures are proposed[5,6].

In India, the systematic collection of data on cancer through the PBCRs and Hospital-Based Cancer Registries is in existence since 1981 under the National Cancer Registry Programme (NCRP), National Centre for Disease Informatics and Research (NCDIR) of the Indian Council of Medical Research (ICMR-NCDIR), Bengaluru.

One of the primary objectives of NCRP is to generate reliable data on the magnitude and patterns of cancer in India and provide future estimates. Our previous publication estimated 1.39 million new (incident) cancer cases in the year 2020[5]. The present article is aimed to provide detailed estimates of cancer incidence in India by sex, age groups and anatomical sites for the year 2022 and the projected rise in cases for 2025, using the same datasets and methodology[5]. In addition, five-year and broad age group-wise cancer estimates were also calculated for the year 2022. Noticeably, GLOBOCAN followed a similar approach for 2020 after publishing the 2018 cancer estimates[1,7].

Material & Methods

The present study was carried out at ICMR-National Centre for Disease Informatics & Research, Bengaluru, Karnataka, India. The study used secondary data for analyses and was granted exemption from review approval by the Institutional Ethics Committee of ICMR-NCDIR (Ref: NCDIR/IEC/3060/2022).

Data sources: NCRP reports 2020 described cancer incidence by sex, 16 age groups (0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74 and 75+; in yrs) and anatomical sites across the 28 PBCRs in India from the year 2012 to 2016[8]. The anatomical sites follow the International Statistical Classification of Diseases and Related Health Problems (ICD-10, 10th revision)[9]. The population at risk was extracted from the Census of India, Registrar General and General Census Commissioner of India for the years 2001 and 2011 by State/Union Territory (UT) and sex[10].

Estimation of Cancer Incidence in India for 2022: Crude incidence rate (CR) per 100,000 was calculated by dividing the total number of cases by the total population. Age-specific incidence rate (ASIR) per 100,000 was derived by dividing the number of cancer cases by the total population in that particular age group. Age-adjusted rate (AAR) was the weighted average of ASIR and world standard population[11]. In the absence of any other competing cause of death, cumulative risk refers to the likelihood that a given individual will be diagnosed with cancer during his or her lifetime between the ages of 0 and 74 years. This was expressed as '1 in how many' are likely to develop cancer during their lifetime.

The PBCRs with a minimum three years' data and incidence rate, consistent with previous years, were included for estimation. The coverage of PBCRs is varied across India, with full/less/no coverage among the States/UTs. The North-East (NE) region has better representativeness over the rest of India, with four NE States (Sikkim, Manipur, Mizoram and Tripura) having 100 per cent PBCR coverage and each NE State with at least one fully functional PBCR. Of the 28 PBCRs rural, urban and semi-urban distributions were one (3.5%), 12 (42.9%) and 15 (53.6%), respectively. There was no sampling method used in selecting PBCRs. The PBCRs of the respective State/region were used to differentiate between rural and urban settings wherever feasible. For example, Chennai and Dindigul PBCRs' rates were used to describe Tamil Nadu State urban and rural rate, respectively[12]. Patiala PBCRs cover both urban and rural areas and have been used for the Punjab State[8]. For regions with less/no PBCR coverage, the pooled incidence rates (combination of rural and urban) were used for the rest of India except for Delhi, Punjab district, Maharashtra and the southern region.

First, the representation of PBCRs by State/region wise was assigned for estimating cancer burden (Supplementary Table I). Then, the Indian States/UT-wise population by five-year age groups till 2022 were calculated using the difference distribution

method from the 2001 to 2011 census growth rate[13]. Thereafter, the ASIR of each specific anatomical site from 2012 to 2016 was applied to the estimated population to derive the number of cancer cases in India for 2022. Cancer estimates for each specific anatomical site were added to get the total estimate of all site cancer (ICD 10: C00-C97). The pooled age, sex- and site-specific incidence rates were computed using the population-weighted average of the rates from the PBCRs. The estimation of cancer incidence was done assuming that the 28 PBCRs represent the country with a constant incidence rate over time.

The same process has been executed to estimate the cancer cases for the year 2025. The statistical analysis and graphs were generated using in-house software Population-Based Cancer Registry Data Management (PBCRDM) version 2.1 and Microsoft Excel.

Results

Table I presents the estimated cancer incidence, number of cases, crude rate and cumulative risk by sex and anatomical sites in India for the year 2022. The estimated number of cancer cases and crude incidence rate in India for the year 2022 was 14,61,427 (100.4 per 100,000), with a greater number of female cases 7,49,251 (105.4 per 100,000) estimated compared to that in males 7,12,176 (95.6 per 100,000). The estimated AAR for all sites of cancer in India would be 107.0 per 100,000. The leading five sites with the highest cancer burden in both sexes were organs of the digestive system (2,88,054), breast (2,21,757), genital system (2,18,319), oral cavity and pharynx (1,98,438) and respiratory system (1,43,062). The cumulative risk to develop cancer in his/her lifetime between 0 and 74 yr was one in every nine persons for all sites of cancer in both sexes, one in 67 for lung cancers in males and one in 29 for breast cancer in females.

Fig. 1 presents the estimated top five leading sites of cancer; among males these were lung (10.6%), mouth (8.4%), prostate (6.1%), tongue (5.9%) and stomach (4.8%). The estimated top five leading sites of cancer among females included breast (28.8%), cervix (10.6%), ovary (6.2%), corpus uteri (3.7%) and lung (3.7%). Liver cancer (3.9%) was among the leading ten cancers in males and not in females, whereas thyroid (3.6%) and gallbladder (2.7%) cancers were in top ten among females but not in males.

Table II provides gender disaggregated, estimated top five leading sites of cancer (%) in India by age group (0-14, 15-39, 40-64, 65+ age group) for the year 2022. In the childhood group (0-14 yr) lymphoid leukaemia is the leading site for both boys (29.3%) and girls (24.3%), followed by the brain nervous system (NS) (boys: 12.4% and girls: 14.3%). In the adolescent and young adult group (15-39 yr), among males, the leading sites are mouth (12.0%), tongue (8.8%), brain NS (7.0%), myeloid leukaemia (6.5%) and non-Hodgkin lymphoma (NHL) (5.9%); among females, breast (27.3%), thyroid (12.2%), ovary (7.3%), cervix (7.1%) and myeloid leukaemia (3.7%). In 40-64 years' age group, among males, the leading sites included the lung (11.0%), mouth (10.9%) and tongue (7.3%). Among females, the leading sites were breast (33.0%), cervix (12.3%) and ovary (6.5%); this age group had a high incidence of cases in both males (3,41,230) and females (4,25,918). Above 65 yr of age, prostate (12.3%) was the second-leading site after lung (13.1%) in males. Above 40 yr of age, lung cancer was the top most common cancer among males while breast cancer topped in females.

Fig. 2 presents the estimated cancer cases and ASIR by five-year age group and gender for India in 2022. The ASIR for all sites of cancer started increasing from 25 years of age in both males and females. However, the ASIR among females aged 25-59 yr was higher than in males. Above 60 yr, the male ASIR was higher than females and it peaked at 75+ yr with 710.6 per 100,000. While in females, the ASIR dropped to 451.7 per 100,000 at 75+ yr. The highest number of cancer cases were in the 60-64 yr age group (males: 1,06,296 and females: 1,05,139).

Table III provides the estimated leading sites of cancer cases by different periods (2015, 2020 and 2025) for leading sites of cancer. While in males, all site - cancers are likely to increase to 7,63,575 in 2025 from 6,01,737 in 2015, in females all site - cancers are likely to increase to 8,06,218 in 2025 from 6,27,202 in 2015. The projected leading cancer cases of the lung and breast would be 81,219 and 2,32,832 among males and females, respectively, for the year 2025. Cancer cases considered together for all sites are expected to increase by 27.7 per cent from 2015 to 2025.

Discussion

In India, the incidence of cancer cases is likely to increase from 1.46 million in 2022 to 1.57 million in 2025. The national average for the year 2022 of crude rate of incidence per 100,000 is 100.4; for males, 95.6 and females, 105.4. Lung and breast cancers in males and females, respectively, remain to be the leading sites

Table I. Estimated number, incidence rate and cumulative risk for all cancer sites in India by sex-2022

Site	Male				Female				Both sexes			
	Cases	CR	AAR	Cum-risk	Cases	CR	AAR	Cum-risk	Cases	CR	AAR	Cum-risk
All sites	712,176	95.6	105.7	1 in 9	749,251	105.4	109.0	1 in 9	1,461,427	100.4	107.0	1 in 9
Oral cavity and pharynx	145,844	19.6	21.2	1 in 42	52,594	7.4	7.7	1 in 115	198,438	13.6	14.4	1 in 62
Tongue	41,845	5.6	6.0	1 in 147	14,611	2.1	2.1	1 in 400	56,456	3.9	4.1	1 in 215
Mouth	60,164	8.1	8.6	1 in 103	23,675	3.3	3.5	1 in 241	83,839	5.8	6.1	1 in 144
Pharynx	3177	0.4	0.5	1 in 1793	1168	0.2	0.2	1 in 5482	4345	0.3	0.3	1 in 2704
Other oral cavity	40,658	5.5	6.1	1 in 137	13,140	1.8	1.9	1 in 475	53,798	3.7	4.0	1 in 213
Digestive system	172,025	23.1	25.9	1 in 32	116,029	16.3	17.0	1 in 50	288,054	19.8	21.4	1 in 39
Oesophagus	34,272	4.6	5.2	1 in 159	21,300	3.0	3.1	1 in 263	55,572	3.8	4.2	1 in 198
Stomach	34,353	4.6	5.2	1 in 160	18,353	2.6	2.7	1 in 319	52,706	3.6	3.9	1 in 213
Small intestine	2255	0.3	0.3	1 in 2498	1533	0.2	0.2	1 in 3877	3788	0.3	0.3	1 in 3041
Colon	21,595	2.9	3.2	1 in 260	16,512	2.3	2.4	1 in 348	38,107	2.6	2.8	1 in 298
Rectum	22,985	3.1	3.4	1 in 244	15,767	2.2	2.3	1 in 372	38,752	2.7	2.8	1 in 295
Anus, anal canal	3037	0.4	0.4	1 in 1865	2131	0.3	0.3	1 in 2682	5168	0.4	0.4	1 in 2200
Liver and intrahepatic bile duct	28,020	3.8	4.3	1 in 189	11,306	1.6	1.7	1 in 514	39,326	2.7	3.0	1 in 276
Gallbladder and other biliary	12,997	1.7	1.9	1 in 423	20,570	2.9	3.0	1 in 283	33,567	2.3	2.5	1 in 339
Pancreas	12,511	1.7	1.9	1 in 429	8557	1.2	1.3	1 in 656	21,068	1.4	1.6	1 in 519
Respiratory system	108,848	14.6	16.2	1 in 48	34,214	4.8	4.8	1 in 165	143,062	9.8	10.4	1 in 74
Larynx	28,542	3.8	4.3	1 in 184	3498	0.5	0.5	1 in 1629	32,040	2.2	2.4	1 in 331
Lung and bronchus	75474	10.1	11.6	1 in 67	27,897	3.9	4.1	1 in 209	103,371	7.1	7.8	1 in 101
Other respiratory organs	4832	0.6	0.3	1 in 1274	2819	0.4	0.2	1 in 2149	7651	0.5	0.2	1 in 1602
Bones and joints	8426	1.1	1.1	1 in 1011	6087	0.9	0.8	1 in 1365	14,513	1.0	1.0	1 in 1160
Soft tissue	8380	1.1	1.2	1 in 844	6895	1.0	1.0	1 in 1050	15,275	1.0	1.1	1 in 936
Skin (excluding basal and squamous)	11,745	1.6	1.7	1 in 510	9412	1.3	1.4	1 in 641	21,157	1.5	1.5	1 in 569
Melanoma of the skin	3145	0.4	0.5	1 in 1909	2479	0.3	0.4	1 in 2288	5624	0.4	0.4	1 in 2081
Other non-epithelial skin	8600	1.2	1.3	1 in 696	6933	1.0	1.0	1 in 891	15,533	1.1	1.1	1 in 782
Breast	5649	0.8	0.8	1 in 1021	216,108	30.4	31.2	1 in 29	221,757	15.2	16.0	1 in 56
Genital system	54,625	7.3	8.4	1 in 105	163,694	23.0	23.9	1 in 37	218,319	15.0	16.0	1 in 53
Uterine cervix	-	-	-	-	79,103	11.1	11.6	1 in 75	79,103	11.1	11.6	1 in 75
Uterine corpus	-	-	-	-	27,922	3.9	4.2	1 in 190	27,922	3.9	4.2	1 in 190
Ovary	-	-	-	-	46,126	6.5	6.7	1 in 133	46,126	6.5	6.7	1 in 133
Vulva	-	-	-	-	2258	0.3	0.3	1 in 2454	2258	0.3	0.3	1 in 2454

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Site	Male				Female				Both sexes			
	Cases	CR	AAR	Cum-risk	Cases	CR	AAR	Cum-risk	Cases	CR	AAR	Cum-risk
Vagina and other genital, female	-	-	-	-	7961	1.1	1.2	1 in 747	7961	1.1	1.2	1 in 747
Placenta	-	-	-	-	324	0.0	0.0	1 in 31,252	324	0.0	0.0	1 in 31,252
Prostate	43,691	5.9	6.8	1 in 125	-	-	-	-	43,691	5.9	6.8	1 in 125
Testis	4521	0.6	0.6	1 in 2092	-	-	-	-	4521	0.6	0.6	1 in 2092
Penis and other genital, male	6413	0.8	1.0	1 in 917	-	-	-	-	6413	0.8	1.0	1 in 917
Urinary system	34,942	4.7	5.3	1 in 158	11,861	1.7	1.8	1 in 500	46,803	3.2	3.5	1 in 240
Urinary bladder	21,523	2.9	3.3	1 in 250	5713	0.8	0.8	1 in 1011	27,236	1.9	2.0	1 in 402
Kidney and renal pelvis	12,963	1.7	2.0	1 in 442	5930	0.8	0.9	1 in 1036	18,893	1.3	1.4	1 in 619
Ureter and other urinary organs	456	0.1	0.1	1 in 10,755	218	0.0	0.0	1 in 21,739	674	0.0	0.1	1 in 14,422
Eye and orbit	1326	0.2	0.2	1 in 6887	977	0.1	0.2	1 in 9049	2303	0.2	0.2	1 in 7799
Brain and other nervous system	20,811	2.8	2.9	1 in 341	13,296	1.9	1.9	1 in 546	34,107	2.3	2.4	1 in 419
Endocrine system	9682	1.3	1.4	1 in 708	27,847	3.9	3.8	1 in 280	37,529	2.6	2.5	1 in 402
Thyroid	8967	1.2	1.2	1 in 758	27,253	3.8	3.7	1 in 285	36,220	2.5	2.4	1 in 416
Adrenal gland	715	0.1	0.1	1 in 10,776	594	0.1	0.1	1 in 13,920	1309	0.1	0.1	1 in 12,146
Lymphoma	34,116	4.6	4.9	1 in 197	21,233	3.0	3.1	1 in 296	55,349	3.8	4.0	1 in 236
Hodgkin lymphoma	7561	1.0	1.0	1 in 1150	4113	0.6	0.6	1 in 1866	11,674	0.8	0.8	1 in 1416
Non-Hodgkin lymphoma	26,497	3.6	3.8	1 in 238	17,070	2.4	2.5	1 in 352	43,567	3.0	3.2	1 in 284
Malig Imn.Prol D	58	0.0	0.0	1 in 103,646	50	0.0	0.0	1 in 163,299	108	0.0	0.0	1 in 127,221
Multiple myeloma	11,261	1.5	1.7	1 in 465	8165	1.1	1.2	1 in 646	19,426	1.3	1.5	1 in 541
Leukaemia	33,604	4.5	4.8	1 in 239	21,969	3.1	3.2	1 in 352	55,573	3.8	4.0	1 in 284
Lymphoid leukaemia	14,546	2.0	2.1	1 in 609	7638	1.1	1.2	1 in 1137	22,184	1.5	1.7	1 in 790
Myeloid leukaemia	15,531	2.1	2.2	1 in 474	11,788	1.7	1.7	1 in 616	27,319	1.9	1.9	1 in 536
Leukaemia unspecified	3527	0.5	0.5	1 in 2292	2543	0.4	0.4	1 in 2974	6070	0.4	0.4	1 in 2585
Other and unspecified primary sites	50,892	6.8	7.6	1 in 114	38,870	5.5	5.7	1 in 153	89,762	6.2	6.6	1 in 131

Cum-risk, cumulative risk of developing cancer in 0-74 yr of age; CR, crude rate; AAR, age-adjusted rate; Malig Imn.Prol D, malignant immunoproliferative diseases

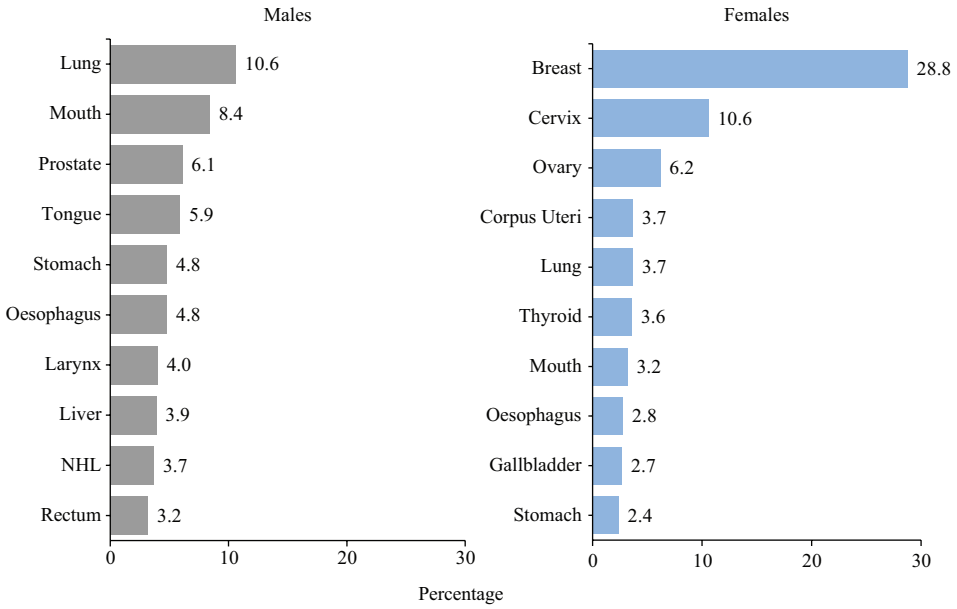

Fig. 1. Estimated proportion of top 10 leading sites of cancer in India by sex – 2022.

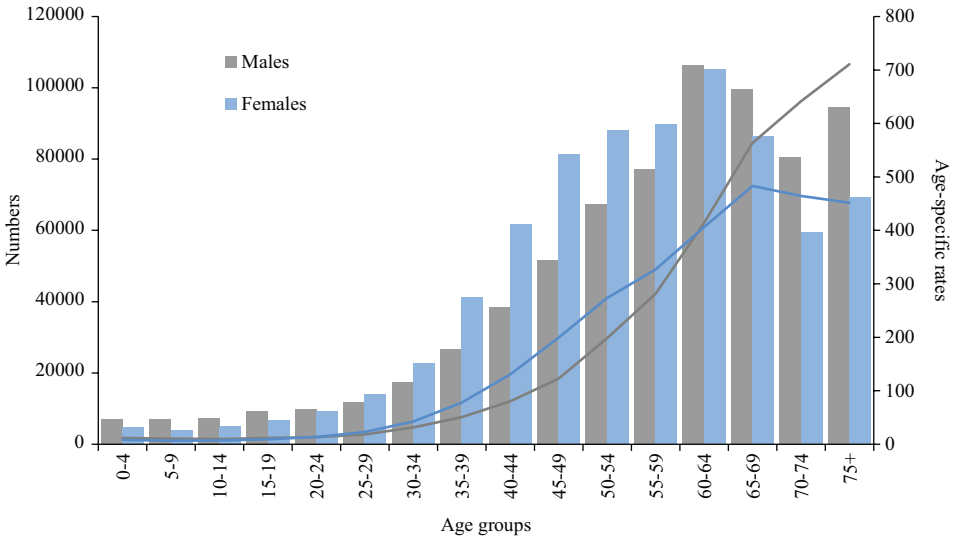

Fig. 2. Estimated age-wise number and incidence rate for all sites of cancer by sex – 2022.

of cancer. Lymphoid leukaemia, followed by brain NS is the leading site of cancer in the childhood age group among both sexes. ASIR increased with increasing age and it was higher in the female reproductive age group (15-49 yr). Lung cancer was estimated to be 1,03,371 cases in 2022 and it featured in the top five leading sites for both males and females. The current estimates for cancer in India increased by five per cent (14,61,427 in 2022 compared to 13,92,179 in 2020)[5].

The NCRP, India, started with three PBCRs located at Bangalore, Mumbai and Chennai in 1982. Based on the data from the three PBCRs, the cancer burden in India was projected for the year 2001[14]. With the expansion of PBCRs, cancer estimate updates were published based on available PBCRs[5,15-18]. Recently, GLOBOCAN estimated the cancer incidence for India for the year 2020 using ASIR from 27 PBCRs of 2012-2014 data and cancer incidence in five continents[4,19]. China had estimated the incidence for the year 2022, assuming that the ASIR in 2020 would continue to be constant[20]. The present study used recently available 28 PBCRs ASIR of 2012-2016

Table II. The estimated top five leading sites of cancer (number and proportion) in India by age group (0-14, 15-39, 40-64, 65+ age group) and sex for the year 2022

Males		Females	
Cancer site	n (%)	Cancer site	n (%)
0-14 yr			
Lymphoid leukaemia (C91)	6233 (29.3)	Lymphoid leukaemia (C91)	3328 (24.3)
Brain and NS (C70-C72)	2643 (12.4)	Brain and NS (C70-C72)	1956 (14.3)
NHL (C82-86, C96)	1679 (7.9)	Bone (C40-C41)	1140 (8.3)
Hodgkin's disease (C81)	1513 (7.1)	Myeloid leukaemia (C92-C94)	1099 (8.0)
Myeloid leukaemia (C92-C94)	1498 (7.0)	NHL (C82-86, C96)	783 (5.7)
Other sites	7742 (36.3)	Other sites	5403 (39.4)
All sites	21,308 (100.0)	All sites	13,709 (100.0)
15-39 yr			
Mouth (C03-C06)	9013 (12.0)	Breast (C50)	25,710 (27.3)
Tongue (C01-C02)	6597 (8.8)	Thyroid (C73)	11,453 (12.2)
Brain and NS (C70-C72)	5230 (7.0)	Ovary (C56)	6877 (7.3)
Myeloid leukaemia (C92-C94)	4881 (6.5)	Cervix (C53)	6714 (7.1)
NHL (C82-86, C96)	4444 (5.9)	Myeloid leukaemia (C92-C94)	3503 (3.7)
Other sites	44,707 (59.7)	Other sites	39,909 (42.4)
All sites	74,872 (100.0)	All sites	94,166 (100.0)
40-64 yr			
Lung (C33-34)	37,376 (11.0)	Breast (C50)	140,384 (33.0)
Mouth (C03-C06)	37,067 (10.9)	Cervix (C53)	52,560 (12.3)
Tongue (C01-C02)	24,951 (7.3)	Ovary (C56)	27,562 (6.5)
Oesophagus (C15)	18,390 (5.4)	Corpus uteri (C54)	18,108 (4.3)
Stomach (C16)	17,741 (5.2)	Lung (C33-34)	14,341 (3.4)
Other sites	205,705 (60.3)	Other sites	172,963 (40.6)
All sites	341,230 (100.0)	All sites	425,918 (100.0)
65+yr			
Lung (C33-34)	36,013 (13.1)	Breast (C50)	49,946 (23.2)
Prostate (C61)	33,695 (12.3)	Cervix (C53)	19,814 (9.2)
Oesophagus (C15)	14,668 (5.3)	Lung (C33-34)	11,793 (5.5)
Stomach (C16)	14,435 (5.3)	Ovary (C56)	11,188 (5.2)
Mouth (C03-C06)	14,035 (5.1)	Mouth (C03-C06)	9060 (4.2)
Other sites	161,920 (58.9)	Other sites	113,657 (52.8)
All sites	274,766 (100.0)	All sites	215,458 (100.0)

NHL, non-Hodgkin lymphoma; NS, nervous system

with a better representation of States to arrive at the projection. The decadal census of 2021 has been delayed due to the COVID-19 pandemic. Post-censal estimates of the 2001-2011 census growth rate were used for the population at risk in India[10,13]. The factors influencing population, such as fertility, mortality and migration, were not incorporated for estimation. NCRP estimate was 5.1 per cent higher than the GLOBOCAN for the year 2020[2]. This difference could be attributable to the difference in methodology, use of recent data and assumptions.

The PBCRs included in the analysis covered approximately 10 per cent of the population in India. Data from some of the populous States (*e.g.* Uttar Pradesh and Bihar) is not yet available for

Table III. Estimated trends in number of cancer cases for the leading sites (ICD-10 codes) in India in 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

ICD, International Classification of Diseases 10th Revision

analysis. India's current NCRP coverage is 16.4 per cent, and the country's urban and rural population coverage rates are 31.6 and 9.5 per cent, respectively. Furthermore, the rural component of PBCRs is not presented in the majority of States. It is therefore recommended that cancer registration be expanded to include a more representative population in each State of India for more reliable projections and to strengthen cancer control activities. Having cancer as a notifiable disease in the country will improve the coverage and provide a better representation as well. Time trends in the cancer incidence rate approach were not followed; rather we assumed the recent available incidence rate (constant) as a conservative approach for this estimation. The increase in cancer cases was attributable to the changes in population dynamics and its growth. India is expected to see an increase in the older age population, and especially the proportion of the population (>60 yr) is expected to increase from 8.6 per cent in 2011 to 9.7 per cent in 2022 (Supplementary Figure)[10]. There would be changes in estimated cancer incidence, which depends upon the risk factors, improvement in case findings, introduction of screening programmes and cancer detection and diagnosis techniques. The COVID-19 pandemic made an impact on the reduction in new cancer registration and delivery of oncology services in India, which was not considered for estimation[21]. As per the International Association of Cancer Registries/International Agency for Research on Cancer (IARC) standards, the PBCRs' quality indicators were followed and published in CI5 volumes[4].

Mortality data were incomplete due to poor coverage of the Civil Registration System, and there are certain limitations in getting cancer as the cause of death. The collection of accurate mortality data has been a big challenge and its quality varies across the PBCRs. Hence, the approach of estimating incidence from mortality or survival was not attempted. Methodological characteristics for cancer estimations were presented from various sources (Supplementary Table II). The longer period (>25 yr) of data is available only from six (5-urban and 1-rural) out of 28 PBCRs. Due to the unavailability of a longer period of data from most of the PBCRs, statistical modelling techniques such as Age-Period-Cohort could not be included. There were several challenges to starting a PBCR in low- and middle-income countries. A sample of regional PBCRs or a series of regional PBCRs with 10 per cent of coverage would get considerable benefit for cancer control purposes[22]. In these circumstances, this is the best available cancer data in the country for estimation. GLOBOCAN, IARC has used the same PBCRs to estimate the burden for India and similarly for some of the neighbouring countries in the South Asia region[19].

A review on the burden of cancer in India attributed the increases to improved cancer diagnostics, cancer data capture and continuing epidemiologic transition[23]. Tobacco-related/lifestyle/ageing-related cancer incidence rate has increased over time for the tongue, mouth, colon, rectum, liver, lung, breast, corpus uteri, ovary, thyroid, prostate, gallbladder, pancreas, kidney, urinary bladder, brain, NHL and lymphoid leukaemia. Meanwhile, a decrease in cancer incidence rate was observed for the hypopharynx, oesophagus, stomach and cervix[24-26]. Alcohol use (30.1%) was the leading attributable risk factor for pharyngeal cancer related Disability Adjusted Life Years (DALYs). Tobacco use and air pollution (43% each) were the attributable risk factors for lung cancer DALYs, whereas dietary factors (43.2%) were attributable to colorectal cancer[27].

Globally, half of the cancer burden was seen in the 65+ age group, while it is one-third of cancer in

India[2]. However, half of the estimated cancer burden is in the 40-64 yr age group in India. The childhood cancer burden accounts for three per cent of boys and 1.8 per cent of girls in the age group of 0-14 yr. The rural population of India reported a lower childhood cancer incidence rate that could be attributed to under-reporting[28,29]. A study on adolescent and young adult cancers showed a significant increase in the incidence among males observed over time[30]. The incidence of cancer cases is estimated to increase to 12.8 per cent in 2025 compared to 2020. A recent publication from NCRP projected the burden of cancer to 29.8 million DALYs by 2025 in India[31].

In summary, the cancer incidence burden is continuing to increase in India. Among the top five cancers in females, breast cancer was found to be the highest, followed by three female genital organs cervix, ovary and corpus uteri. Among males, three sites; lung, mouth and tongue were limited with tobacco-related cancers. A preventable measure needs to be taken for reducing the future burden of cancer. The new estimates are helpful for cancer prevention and control activities through the intervention of early detection, risk reduction and management in India. Appropriate research is, however, needed to delve deeper into the reasons of cancer burden and provide affordable solutions.

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Supplementary Table I. State/region wise representation of Population-Based Cancer Registry in India

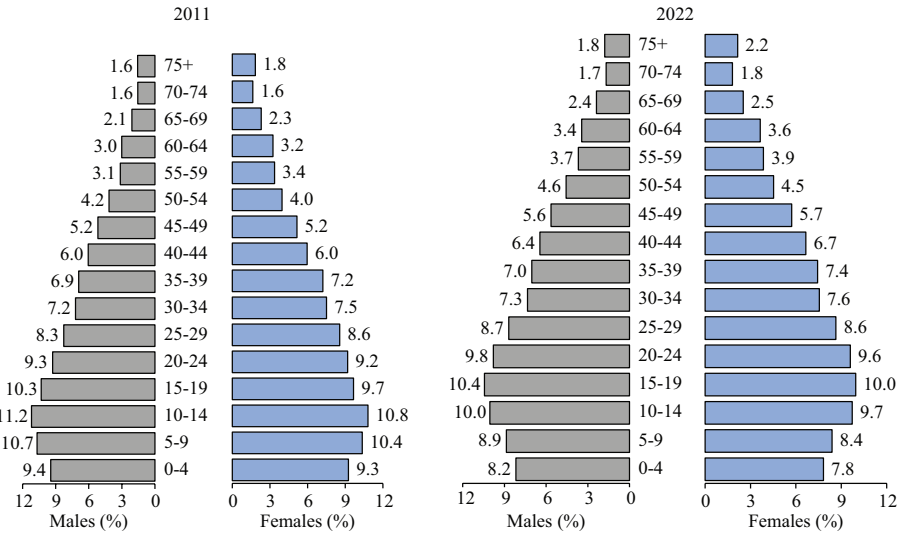
Regions	State/UT	PBCR representation
North	Chandigarh	Pooled Rest of India
	Delhi	Delhi
	Haryana	Pooled Rest of India
	Himachal Pradesh	Pooled Rest of India
	Jammu and Kashmir, Ladakh	Pooled Rest of India
	Punjab	Patiala
	Uttarakand	Pooled Rest of India
North East	Arunachal Pradesh	Pooled (West Arunachal, Pasighat)
	Assam	Pooled (Cachar, Kamrup, Dibrugarh)
	Manipur	Manipur state
	Meghalaya	Meghalaya
	Mizoram	Mizoram state
	Nagaland	Kohima, Dimapur
	Sikkim	Sikkim state
	Tripura	Tripura state
East	Bihar	Pooled Rest of India
	Jharkhand	Pooled Rest of India
	Orissa	Pooled Rest of India
	West Bengal	Pooled Rest of India
Central	Chattisgarh	Pooled Rest of India
	Madhya Pradesh	Pooled Rest of India
	Rajasthan	Pooled Rest of India
	Uttar Pradesh	Pooled Rest of India
West	Dadra and Nagar Haveli	Pooled Rest of India
	Daman and Diu	Pooled Rest of India
	Goa	Pooled Maharashtra
	Gujarat	Pooled Rest of India
	Maharashtra	Pooled Maharashtra
South	Andhra Pradesh	Pooled South
	Telangana	Pooled South
	Andaman and Nicobar Islands	Pooled South
	Karnataka	Pooled South
	Kerala	Pooled Thiruvananthapuram district, Kollam district
	Lakshadweep	Pooled South
	Puducherry	Chennai-U, Dindigul-R
	Tamil Nadu	Chennai-U, Dindigul-R

Pooled south, PBCRs of Chennai, Bangalore, Thiruvanathapuram district, Kollam district, Hyderabad, Dindigul; Pooled Maharashtra, All PBCRs from Maharashtra (Mumbai, Aurangabad, Nagpur, Pune, Wardha district, Barshi rural, Osmanabad and Beed); Pooled rest of India, All PBCRs from other than north-east region. U, urban; R, rural; PBCR, Population-Based Cancer Registry

Supplementary Table II. Differences in burden estimation methods for India by selected sources

Characteristics	GLOBOCAN[1,2]	GBD[27]	NCRP
Data sources	PBCRs (27) from the NCRP 2012-2014 and Dindigul, Mansa, Sangrur PBCRs incidence data	PBCRs (42) and Sample Registration System, cause of death data from India. Cancer registry data were used as the gold standard	PBCRs (28) from the NCRP, 2020 report of 2012-2016 and Dindigul PBCR incidence data
Population estimates	North East States, India's rural and urban population derived from United Nation and Census of India, 2011	Not mentioned	State wise population estimation based on Census of India, 2011
Exclusion	Hospital-Based Cancer Registry	Hospital-Based Cancer Registry	Hospital-Based Cancer Registry
Method	Weighted average of the most recent local rates applied to 2020 population	Mortality estimates arrived by multiplying incidence with modelled mortality-incidence ratio The estimation of cancer incidence is based on registry data from India	Weighted average of the most recent local rates (2012-2016) applied to 2022 population
Cancer measure	Age specific incidence rate by site, sex and age	Mortality data from vital registration used as base to calculate the different measures	Age-specific incidence rate by site, sex and age
Outcome	Incidence and rates for India	Cancer mortality, incidence and DALY's by State/India	Incidence and rates for India

GLOBOCAN, Global Cancer Observatory; GBD, Global Burden of Disease; PBCR, Population-Based Cancer Registry; NCRP, National Cancer Registry Programme; DALY, Disability-Adjusted Life Years



Supplementary Figure. Population pyramids for proportion (%) of census 2011 and estimated 2022 by sex, age group in India.