PURPOSE The systematic collection of data on cancer is being performed by various population-based cancer registries (PBCRs) and hospital-based cancer registries (HBCRs) across India under the National Cancer Registry Programme–National Centre for Disease Informatics and Research (NCDIR) of the Indian Council of Medical Research since 1982.

METHODS This study examined the cancer incidence, patterns, trends, projections, and mortality from 28 PBCRs and also the stage at presentation and type of treatment of patients with cancer from 58 HBCRs (N = 667,666) from the pooled analysis for the composite period 2012-2016. Time trends in cancer incidence rate were generated as annual percent change from 16 PBCRs (those with a minimum of 10 years of continuous good data available) using Joinpoint regression.

RESULTS Aizawl district (269.4) and Papumpare district (219.8) had the highest age-adjusted incidence rates among males and females, respectively. The projected number of patients with cancer in India is 1,392,179 for the year 2020, and the common 5 leading sites are breast, lung, mouth, cervix uteri, and tongue. Trends in cancer incidence rate showed an increase in all sites of cancer in both sexes and were high in Kamrup urban (annual percent change, 3.8%; \( P < .05 \)). The majority of the patients with cancer were diagnosed at the locally advanced stage for breast (57.0%), cervix uteri (60.0%), head and neck (66.6%), and stomach (50.8%) cancer, whereas in lung cancer, distant metastasis was predominant among males (44.0%) and females (47.6%).

CONCLUSION This study provides a framework for assessing the status and trends of cancer in India. It shall guide appropriate support for action to strengthen efforts to improve cancer prevention and control to achieve the national noncommunicable disease targets and the sustainable development goals.

JCO Global Oncol 6:1063-1075. © 2020 by American Society of Clinical Oncology

INTRODUCTION Globally, noncommunicable diseases (NCDs) accounted for 71% of total deaths. In India, NCDs were estimated to account for 63% of all deaths, and cancer was one of the leading causes (9%). Cancer registries are recognized as vital components of national cancer-control programs. Publications from developed and developing countries provide updated information on cancer occurrence, trends, and projections. In India, the systematic collection of data on cancer has been performed since 1982 by the population-based cancer registries (PBCRs) and hospital-based cancer registries (HBCRs) under the National Cancer Registry Programme (NCRP)–National Centre for Disease Informatics and Research (NCDIR) of the Indian Council of Medical Research (ICMR; ICMR-NCDIR-NCRP), Bengaluru (Appendix). NCRP commenced with the objective of generating reliable data on the magnitude and patterns of cancer. Several NCRP reports on cancer from different registries across India have been published.

PBCRs provide statistics on the occurrence and outcome of cancer in a geographically defined population. They also provide the framework for assessing the control of cancer in the community. HBCRs are concerned with the recording of information on patients with cancer seen in a particular hospital and are mainly used for reviewing clinical performance and the hospital cancer program.

This article reports the cancer incidence, patterns, time trends, and mortality from 28 PBCRs for the composite period 2012-2016 across India under ICMR-NCDIR-NCRP. Also, it covers the stage at presentation and type of treatment received by patients with cancer from 58 HBCRs for the period 2012-2016 in India under the...
CONTEXT

Key Objective
This study reports the cancer incidence, patterns, trends, projections, cancer mortality, and clinical aspects of stage at presentation and treatment for the period 2012-2016 from 28 population-based and 58 hospital-based cancer registries in India under the network of the National Cancer Registry Programme.

Knowledge Generated
There is heterogeneity in cancer incidence (age-adjusted rate per 100,000: males: Osmanabad and Beed, 39.5 v Aizawl district, 269.4; females: Osmanabad and Beed, 49.4 v Papumpare district, 219.8) and in patterns across India and a lower proportion (< 33%) of early stage at presentation for common cancers. The projected incidence of patients with cancer for the year 2020 in India in males is 679,421 and in females is 712,758.

Relevance
Results of this study will help in assessing the status and trends of cancer in India. This will assist local- and national-level stakeholders to implement public health action to control cancer.

METHODS

Presently, there are 36 PBCRs and 236 HBCRs registered under the ICMR-NCDIR-NCRP. However, this article includes data from 28 PBCRs and 58 HBCRs, which were complete with at least 1 year of good-quality data. All neoplasms with a behavior code of 3 as defined by the International Classification of Diseases for Oncology, 3rd Edition, and the International Statistical Classification of Diseases and Related Health Problems (10th revision; ICD-10) were considered reportable and therefore registered in NCRP.11 Cancer registration is a complex process. In India, cancer registration is active wherein trained registry staff go to different sources (hospitals, diagnostic laboratories, vital statistics departments) for collection of data on a standardized core form.10 This is followed by quality control checks, duplicate checks, matching with mortality cases, follow-up of death certificate notifications, and assigning death certificate only (DCO). Patients with cancer who were residents in the registration area for a minimum period of 1 year before the date of diagnosis were included in the registry. Multiple cancer data sources were followed for data collection.10 Quality of the data was maintained per International Association of Cancer Registries/International Agency for Research on Cancer (IACR/IARC) norms.12,13 Incidence and mortality data were retrieved from 28 PBCRs (urban or rural, or both) for the period 2012-2016. Cancer burden measures were calculated as crude rate, age-adjusted rate (AAR) per 100,000 population using world standard population,14 and cumulative risk (probability that an individual will be diagnosed with cancer [0- to 74-year-old age group] in the absence of any competing cause of death and assuming that the current trends prevail over the time period). Time trends in cancer incidence rate were generated as annual percent change (APC) and considered statistically significant (at $P < .05$) from 16 PBCRs (with minimum of 10 years of data) using the Joinpoint regression program, 4.0.1 (National Cancer Institute).15 The years of data for trend analysis varied (11 to 35 years) across the PBCRs, and there were 6 PBCRs with more than 25 years of continuous data.

The country was categorized into 6 geographic zones based on the location of the PBCRs: North (Delhi, Patiala), South (Hyderabad, Kollam, Thiruvananthapuram, Bangalore, and Chennai), East (Kolkata), West (Ahmedabad urban, Aurangabad, Osmanabad and Beed, Barshi rural, Mumbai, and Pune), Central (Wardha, Bhopal, and Nagpur) and Northeast (NE; Manipur, Mizoram, Sikkim, Tripura, West Arunachal, Meghalaya, Nagaland, Pasighat, Cachar, Dibrugarh, and Kamrup urban). Population denominators were derived from the Census of India, conducted by the Registrar General and Census Commissioner of India under the Ministry of Home Affairs, Government of India.16 The census populations of 2001 and 2011 were used to calculate the postcensal population estimates for the years 2012 and 2016 by 5-year age groups and sex. For time trend analysis, the respective 1981, 1991, 2001, and 2011 censuses were taken as the base to estimate inter- or postcensal population by 5-year age groups and sex.17

A standardized patient information form for HBCRs under NCRP and the data collection methods have been explained previously.18 Newly diagnosed and treated patients with cancer (N = 667,666) from 58 HBCRs (with a minimum of 1 year of a complete dataset) in 2012-2016 were pooled and are presented as the relative proportion of clinical stage and treatment. The stage/clinical extent of disease before treatment (excludes previously treated patients with cancer) was classified into localized only, locoregional, distant metastasis, and unknown.19 The completion of planned cancer-directed treatment after
| Serial No. | Registry (period of reference) | CR | AAR  | Cum Risk | AAMR  | CR | AAR  | Cum Risk | AAMR  |
|-----------|--------------------------------|----|------|----------|-------|----|------|----------|-------|
|           | North                          |    |      |          |       |    |      |          |       |
| 1         | Delhi (2012-14)                | 10,344 | 112.3 | 147.0 | 1 in 6 | 9,688 | 119.6 | 141.0 | 1 in 7 | 17.8 |
| 2         | Patiala district (2012-16)     | 1,079 | 101.6 | 108.2 | 1 in 9 | 1,215 | 127.7 | 124.6 | 1 in 8 | 30.1 |
| 3         | Hyderabad district (2014-16)   | 1,714 | 84.2  | 101.6 | 1 in 9 | 2,151 | 109.8 | 136.0 | 1 in 7 | 12.5 |
| 4         | Kollam district (2012-16)      | 1,986 | 159.4 | 127.7 | 1 in 7 | 1,956 | 139.1 | 107.1 | 1 in 9 | 38.3 |
| 5         | Thiruvananthapuram district (2012-16) | 2,701 | 170.4 | 137.8 | 1 in 7 | 2,865 | 164.8 | 127.3 | 1 in 8 | 39.5 |
| 6         | Bangalore (2012-14)            | 4,407 | 96.8  | 122.1 | 1 in 7 | 5,276 | 125.1 | 146.8 | 1 in 6 | 41.5 |
| 7         | Chennai (2012-16)              | 2,894 | 121.8 | 119.9 | 1 in 8 | 3,361 | 141.4 | 132.8 | 1 in 7 | 28.8 |
|           | South                          |    |      |          |       |    |      |          |       |
| 8         | Kolkata (2012-15)              | 2,547 | 109.9 | 91.2   | 1 in 10 | 2,288 | 105.9 | 89.2   | 1 in 11 | 32.1 |
| 9         | Ahmedabad urban (2012-16)      | 2,916 | 89.1  | 98.3   | 1 in 9 | 2,205 | 74.7  | 76.7   | 1 in 12 | 16.9 |
| 10        | Aurangabad (2012-16)           | 385  | 56.6  | 70.9   | 1 in 13 | 400  | 62.9  | 75.1   | 1 in 12 | 8.5  |
| 11        | Osmanabad and Beed (2012-15)   | 909  | 39.3  | 39.5   | 1 in 23 | 1,117 | 52.8  | 49.4   | 1 in 19 | 10.4 |
| 12        | Barshi Rural (2012-16)         | 145  | 53.9  | 50.6   | 1 in 17 | 163  | 67.2  | 61.0   | 1 in 15 | 36.1 |
| 13        | Mumbai (2012-15)               | 6,564 | 97.3  | 108.4  | 1 in 9 | 6,865 | 117.6 | 116.2  | 1 in 8 | 61.4 |
| 14        | Pune (2012-16)                 | 1,937 | 67.5  | 83.0   | 1 in 11 | 2,164 | 83.3  | 94.0   | 1 in 10 | 35.3 |
|           | East                           |    |      |          |       |    |      |          |       |
| 15        | Wardha district (2012-16)      | 478  | 70.4  | 64.5   | 1 in 14 | 507  | 78.7  | 69.9   | 1 in 14 | 37.1 |
| 16        | Bhopal (2012-15)               | 892  | 83.3  | 101.0  | 1 in 9 | 897  | 90.4  | 106.9  | 1 in 8 | 30.9 |
| 17        | Nagpur (2012-16)               | 1,190 | 89.0  | 91.1   | 1 in 10 | 1,209 | 93.1  | 89.8   | 1 in 11 | 17.7 |
|           | Central                        |    |      |          |       |    |      |          |       |
| 18        | Manipur state (2012-16)        | 740  | 47.0  | 62.8   | 1 in 14 | 900  | 57.8  | 71.1   | 1 in 12 | 17.3 |
|           | Imphal West District (2012-16)  | 227  | 85.1  | 95.3   | 1 in 9 | 300  | 107.9 | 110.9  | 1 in 8 | 24.3 |
| 19        | Mizoram state (2012-16)        | 865  | 146.1 | 207.0  | 1 in 5 | 747  | 127.5 | 172.3  | 1 in 5 | 76.4 |
| 20        | Aizawl district (2012-16)      | 436  | 206.2 | 269.4  | 1 in 4 | 380  | 174.6 | 214.1  | 1 in 5 | 89.5 |
| 21        | Sikkim state (2012-16)         | 234  | 69.9  | 88.7   | 1 in 10 | 226  | 75.3  | 97.0   | 1 in 10 | 46.2 |
| 22        | Tripura state (2012-16)        | 1,312 | 67.0  | 80.9   | 1 in 11 | 983  | 52.0  | 58.3   | 1 in 15 | 28.9 |
| 23        | West Arunachal (2012-16)       | 244  | 56.6  | 101.1  | 1 in 8 | 234  | 56.3  | 96.3   | 1 in 10 | 18.9 |
| 24        | Papumpare district (2012-16)   | 94   | 94.8  | 201.2  | 1 in 4 | 106  | 105.1 | 219.8  | 1 in 4 | 37.9 |
| 25        | Meghalaya (2012-16)            | 938  | 92.6  | 176.8  | 1 in 5 | 566  | 55.7  | 96.5   | 1 in 9 | 38.1 |
| 26        | East Khasi Hills (2012-16)     | 577  | 131.0 | 227.9  | 1 in 4 | 346  | 76.9  | 118.6  | 1 in 8 | 51.5 |
| 27        | Nagaland (2012-16)             | 281  | 74.5  | 124.5  | 1 in 7 | 198  | 56.3  | 88.2   | 1 in 10 | 11.1 |
| 28        | Kamrup urban (2012-16)         | 1,245 | 190.5 | 213.0  | 1 in 4 | 958  | 150.8 | 169.6  | 1 in 6 | 37.3 |

NOTE. Reporting year data given in parentheses; Meghalaya covers East Khasi Hills, West Khasi Hills, Jaintia Hills, and Ri Bhoi districts; Nagaland covers Kohima and Dimapur districts; Pasighat covers East Siang and Upper Siang; West Arunachal covers Tawang, West Kameng, East Kameng, Upper Subansiri, Lower Subansiri, Kurung Kumey, Papumpare, and West Siang districts.

Abbreviations: AAMR, age-adjusted mortality rate per 100,000; AAR, age-adjusted rate per 100,000; CR, crude rate per 100,000; cum risk, cumulative risk of developing any site of cancer 0-74 years of age; NCRP, National Cancer Registry Program; PBCR, population-based cancer registry.
diagnosis was classified as surgery, radiotherapy, systemic therapy, and multimodality (combination of surgery and/or radiotherapy and/or systemic therapy).

Good-quality data indices of microscopic verification (MV%) above 75%, DCO% below 20%, other and unspecified sites (O&U%) below 15%, and mortality-to-incidence ratio (M:I%) were calculated for each PBCR and accordingly classified. NCRP has developed in-house software (PBCR and HBCR Data Management) for data capture, quality checks, duplicates checks (deterministic and phonetic-similar sounding duplicate names), and mortality-incidence matching. The list of errors was sent back to registries for clarification and corrections at each level. Incidence data for 2012-2016 was used as a reference for projection of patients with cancer in India until 2020 by sex and anatomical site. On comparison of AARs for all sites of cancer (ICD10: C00-C97) across the population among males, Aizawl district, Papumpare district, East Khasi Hills district, and Kamrup urban are likely to develop cancer in the age group of 0-74 years. One of every 4 females in the Papumpare district and 1 of 5 females in Mizoram state are likely to develop cancer in the age group of 0-74 years. One of every 4 males in Aizawl district had the highest AAR (269.4) and mortality (152.7) rate among males. One of every 4 males in Aizawl district, Papumpare district, East Khasi Hills district, and Kamrup urban are likely to develop cancer in the age group of 0-74 years. One of every 4 females in the Papumpare district and 1 of 5 females in Mizoram state are likely to develop cancer in the age group of 0-74 years.

![Graph](https://example.com/graph.png)

**FIG 1.** Comparison of all cancer sites’ age-adjusted incidence rates (AARs) of all population-based cancer registries, 2012-2016 (International Statistical Classification of Diseases and Related Health Problems, 10th revision: C00-C97). AARs are in blue and crude rates are given in parentheses in red. Thiruvananthapuram district, Thiruvananthapuram district.
respectively. The higher proportion of cancers associated with use of tobacco was in the NE states, followed by registries in the West and Central regions (Fig 2).

Among males, lung, mouth, esophagus, and stomach were the most common cancer sites. Among females, breast cancer, followed by cervix uteri and ovary cancer, were the most common sites across the PBCRs. Thyroid cancer was the second most common cancer in the PBCRs of Thiruvananthapuram and Kollam, whereas lung cancer was seen in Manipur and Mizoram state. In the NE region, the third most common cancers were stomach and gallbladder (Data Supplement). The decadal changes in leading sites of
cancer from 6 older PBCRs (Barshi rural, Bangalore, Bhopal, Chennai, Delhi, and Mumbai) were observed for the first 10 and last 10 years of data (Data Supplement).

The relative proportion of patients according to clinical extent of disease at the time of diagnosis as seen in the pooled data of 58 HBCRs for common sites of cancer showed that the majority of patients with cancer were diagnosed as locally advanced/locoregional for breast (57.0%), cervix uteri (60.0%), head and neck (66.6%), and stomach (50.8%) cancer. The majority of patients with lung cancer were diagnosed with distant metastasis in males (44.0%) and females (47.6%; Fig 3). The relative proportion of types of cancer-directed treatment received (only at the reporting hospital) according to clinical extent of disease before treatment showed that multimodality was the first choice of treatment (locoregional, 79.5%; localized, 74.4%; distant metastasis, 47.6%; Data Supplement).

The estimated APC in cancer AAR for selected anatomic sites of cancer over the time period showed an increase in the incidence rate of all sites of cancer (12 PBCRs in males and 13 PBCRs in females). There was a significant decrease in the incidence rate of cervical cancer in 10 PBCRs, except in Dibrugarh district and Pune. Lung cancer showed a significant increase in 11 PBCRs among females (Fig 4).

Among 28 PBCRs, MV%, ranged between 77% (Patiala) and 96.7% (Hyderabad); DCO% ranged between 0.05% (Osmanabad and Beed) and 19.4% (Patiala); O&U% ranged between 1.8% (Hyderabad) and 13.0% (Patiala). M:I% was high in Barshi rural (67.2%) followed by Wardha (59.2%) and Mumbai (56.0%; Data Supplement).

The projected incidence of patients with cancer in India among males was 679,421 (94.1 per 100,000) and among females 712,758 (103.6 per 100,000) for the year 2020. One in 68 males (lung cancer), 1 in 29 females (breast cancer), and 1 in 9 Indians will develop cancer during their lifetime (0-74 years of age; Table 2). The projected 5 most common cancers in 2020 for males (lung, mouth, prostate, tongue, and stomach) constitute 36% of all cancers and for females (breast, cervix uteri, ovary, corpus uteri, and lung) constitute 53% of all cancers (Data Supplement).

**DISCUSSION**

India exhibits heterogeneity in cancer. The incidence rates of Aizawl district were observed to be 7 times and 4 times...

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**FIG 3.** Relative proportion (%) of patients according to clinical extent of disease, 2012-2016 (proportion [%] may not total 100% because of rounding).

| Disease          | Proportion (%) |
|------------------|----------------|
| **Breast (Female)** |                |
| Localized only   | 29.0           |
| Loco regional    | 57.0           |
| Distant metastasis | 10.3          |
| Unknown extent   | 3.7            |

| **Cervix Uteri** |                |
|------------------|----------------|
| Localized only   | 32.8           |
| Loco regional    | 60.0           |
| Distant metastasis | 5.1          |
| Unknown extent   | 2.2            |

| **Head & Neck (both sexes)** |                |
|------------------------------|----------------|
| Localized only               | 25.2           |
| Loco regional                | 46.6           |
| Distant metastasis           | 4.8            |
| Unknown extent               | 3.4            |

| **Stomach (both sexes)** |                |
|----------------------------|----------------|
| Localized only             | 18.7           |
| Loco regional              | 50.8           |
| Distant metastasis         | 24.7           |
| Unknown extent             | 5.8            |

| **Lung (male)** |                |
|-----------------|----------------|
| Localized only  | 13.9           |
| Loco regional   | 37.0           |
| Distant metastasis | 44.0          |
| Unknown extent  | 5.1            |

| **Lung (female)** |                |
|-------------------|----------------|
| Localized only    | 17.0           |
| Loco regional     | 29.8           |
| Distant metastasis | 47.6          |
| Unknown extent    | 5.6            |
that of Osmanabad and Beed district PBCRs in males and females, respectively. The highest cancer incidence rate was observed in the NE region (6 PBCRs for males and 4 PBCRs for females) than other areas in the country. The leading sites of cancer in the NE region were nasopharynx, hypopharynx, esophagus, stomach, liver, gallbladder, larynx, lung, breast, and cervix uteri. The NE region lacks required infrastructure with respect to specialized treatment facilities, human resources, as seen by the low 5-year survival of breast, cervix, and head and neck cancer compared with rest of India. A substantial proportion of patients with cancer from the NE region are traveling outside the NE for treatment and cancer care. Local cultural factors and lifestyle choices may have contributed to the heterogeneity in cancer incidence pattern and differences in India, as was seen in Thailand.

Lung (9 PBCRs), mouth (9 PBCRs), esophagus (5 PBCRs), stomach (4 PBCRs), and nasopharynx (1 PBCR) cancers were the most common cancers in men. Lung cancer was the leading site in metropolitan cities and the southern region, whereas mouth cancer was the leading site in the West and Central regions. Lung cancer and oral/mouth cancer were the most common cancers among males in the Indian subcontinent. Cancers of the esophagus, stomach, and nasopharynx were the leading sites in the NE region of India. Here, the cancer incidence pattern is different from the rest of India. There are similarities in the cancer incidence pattern with the Southeast Asian region. Overall, these findings on patterns of cancer were similar to previously published reports under NCRP.

Cancer of the breast (19 PBCRs) and cervix uteri (7 PBCRs) were the most common cancers in women. The highest burden of breast cancer was observed in metropolitan cities. There is an increase in the trend of incidence of breast cancer, whereas cervix uteri cancer is on the decline. A steady increase in breast cancer in most of the PBCRs including newer PBCRs, poses a great health challenge to women in India. Presently, breast cancer and cervix uteri are the leading sites of cancer among women in India, posing an important public health problem that needs important input from various health and other agencies to tackle. A multidisciplinary approach to breast cancer, including awareness programs, preventive measures, screening programs for early detection, and availability of treatment facilities, are vital for reducing both incidence and mortality of cancer in Indian women.

The incidence rate of thyroid cancer among women is increasing, and it is most common in the districts of Thrivunanthapuram and Kollam in Kerala. The high burden of thyroid cancer in Kerala could be due to overdiagnosis, as was observed even in high-income and low- and middle-income countries. AAR in Barshi rural is almost one third of urban PBCRs (males, 50.6 v 147.0; females, 61.0 v 146.8), and the increase in APC was...
| Site                          | Male Patients | CR | Cum Risk | Female Patients | CR | Cum Risk | Both Sexes Patients | CR | Cum Risk |
|------------------------------|---------------|----|----------|-----------------|----|----------|---------------------|----|----------|
| All sites                    | 679,421       | 94.1 | 1 in 9   | 712,758         | 103.6 | 1 in 9   | 1,392,179           | 98.7 | 1 in 9   |
| Oral cavity and pharynx      | 139,018       | 19.2 | 1 in 41  | 49,951          | 7.3  | 1 in 112 | 188,969             | 13.4 | 1 in 60  |
| Tongue                       | 39,902        | 5.5  | 1 in 147 | 13,870          | 2.0  | 1 in 401 | 53,772              | 3.8  | 1 in 215 |
| Mouth                        | 57,380        | 7.9  | 1 in 103 | 22,483          | 3.3  | 1 in 241 | 79,863              | 5.7  | 1 in 144 |
| Pharynx                      | 3,029         | 0.4  | 1 in 1,793 | 1,102         | 0.2  | 1 in 5,475 | 4,131               | 0.3  | 1 in 2,701 |
| Other oral cavity            | 38,707        | 5.4  | 1 in 137 | 12,496          | 1.8  | 1 in 476 | 51,203              | 3.6  | 1 in 213 |
| Digestive system             | 163,845       | 22.7 | 1 in 32  | 110,137         | 16.0 | 1 in 50  | 273,982             | 19.4 | 1 in 39  |
| Esophagus                    | 32,622        | 4.5  | 1 in 159 | 20,206          | 2.9  | 1 in 264 | 52,828              | 3.7  | 1 in 198 |
| Stomach                      | 32,713        | 4.5  | 1 in 160 | 17,430          | 2.5  | 1 in 319 | 50,143              | 3.6  | 1 in 213 |
| Small intestine              | 2,155         | 0.3  | 1 in 2,492 | 1,451         | 0.2  | 1 in 3,901 | 3,606               | 0.3  | 1 in 2,044 |
| Colon                        | 20,572        | 2.8  | 1 in 260 | 15,685          | 2.3  | 1 in 348 | 36,257              | 2.6  | 1 in 298 |
| Rectum                       | 21,915        | 3.0  | 1 in 244 | 14,985          | 2.2  | 1 in 372 | 36,900              | 2.6  | 1 in 295 |
| Anus, anal canal             | 2,897         | 0.4  | 1 in 1,865 | 2,028         | 0.3  | 1 in 2,682 | 4,925               | 0.3  | 1 in 2,200 |
| Liver and intrahepatic bile duct | 26,678 | 3.7  | 1 in 189 | 10,732          | 1.6  | 1 in 514 | 37,410              | 2.7  | 1 in 277 |
| Gallbladder and other biliary | 12,385 | 1.7  | 1 in 422 | 19,510          | 2.8  | 1 in 284 | 31,895              | 2.3  | 1 in 340 |
| Pancreas                     | 11,908        | 1.6  | 1 in 429 | 8,110           | 1.2  | 1 in 657 | 20,018              | 1.4  | 1 in 519 |
| Respiratory system           | 103,552       | 14.3 | 1 in 48  | 32,480          | 4.7  | 1 in 165 | 136,032             | 9.6  | 1 in 74  |
| Larynx                       | 27,146        | 3.8  | 1 in 184 | 3,316           | 0.5  | 1 in 1,633 | 30,462              | 2.2  | 1 in 331 |
| Lung and bronchus            | 71,788        | 9.9  | 1 in 68  | 26,490          | 3.9  | 1 in 201 | 98,278              | 7.0  | 1 in 101 |
| Other respiratory organs     | 4,618         | 0.6  | 1 in 1,273 | 2,674         | 0.4  | 1 in 2,156 | 7,292               | 0.5  | 1 in 1,600 |
| Bones and joints             | 8,115         | 1.1  | 1 in 1,013 | 5,840         | 0.8  | 1 in 1,370 | 13,955              | 1.0  | 1 in 1,162 |
| Soft issue                   | 8,047         | 1.1  | 1 in 842 | 6,590           | 1.0  | 1 in 1,052 | 14,637              | 1.0  | 1 in 936 |
| Skin (excluding basal and squamous) | 11,203 | 1.6  | 1 in 510 | 8,962           | 1.3  | 1 in 640 | 20,165              | 1.4  | 1 in 568 |
| Melanoma of the skin         | 3,003         | 0.4  | 1 in 1,904 | 2,364         | 0.3  | 1 in 2,281 | 5,367               | 0.4  | 1 in 2,075 |
| Other nonepithelial skin     | 8,200         | 1.1  | 1 in 695 | 6,598           | 1.0  | 1 in 890 | 14,798              | 1.0  | 1 in 781 |
| Breast                       | 5,377         | 0.7  | 1 in 1,022 | 205,424       | 29.9 | 1 in 29  | 210,801             | 15.0 | 1 in 56  |
| Genital system               | 51,994        | 7.2  | 1 in 105 | 155,630         | 22.6 | 1 in 36  | 207,624             | 14.7 | 1 in 54  |
| Uterine cervix               | —             | —    | —         | 75,209          | 10.9 | 1 in 75  | 75,209              | 10.9 | 1 in 75  |
| Uterine corpus               | —             | —    | —         | 26,514          | 3.9  | 1 in 190 | 26,514              | 3.9  | 1 in 190 |
| Ovary                        | —             | —    | —         | 43,866          | 6.4  | 1 in 133 | 43,866              | 6.4  | 1 in 133 |
| Vulva                        | —             | —    | —         | 2,138           | 0.3  | 1 in 2,459 | 2,138               | 0.3  | 1 in 2,459 |
| Vagina and other genital, female | —     | —    | —         | 7,570           | 1.1  | 1 in 745 | 7,570               | 1.1  | 1 in 745 |
| Placenta                     | —             | —    | —         | 313             | 0.0  | 1 in 30,912 | 313                | 0.0  | 1 in 30,912 |
| Prostate                     | 41,532        | 5.7  | 1 in 125 | —               | —    | —         | 41,532              | 5.7  | 1 in 125 |
| Testis                       | 4,352         | 0.6  | 1 in 2,095 | —             | —    | —         | 4,352               | 0.6  | 1 in 2,095 |
| Penis and other genital, male | 6,110 | 0.8  | 1 in 916 | —               | —    | —         | 6,110               | 0.8  | 1 in 916 |
| Urinary system               | 33,269        | 4.6  | 1 in 158 | 11,265          | 1.6  | 1 in 502 | 44,534              | 3.2  | 1 in 240 |
| Urinary bladder              | 20,470        | 2.8  | 1 in 250 | 5,403           | 0.8  | 1 in 1,014 | 25,873              | 1.8  | 1 in 402 |
| Kidney and renal pelvis      | 12,363        | 1.7  | 1 in 442 | 5,657           | 0.8  | 1 in 1,038 | 18,020              | 1.3  | 1 in 620 |

(Continued on following page)
less compared with urban PBCRs. This needs additional investigation.

There are cancers of several anatomic sites known to be associated with the use of tobacco. Based on PBCR data, almost one third of the cancers were known to be associated with the use of tobacco in India. India state-level disease burden initiative cancer collaborators estimated that tobacco use was the highest contributing risk factor for cancer in India. In India, lung cancer can be attributed to tobacco use and air pollution, which are the leading risk factors. Approximately 70% of cancers in India were potentially preventable through modifiable risk factors.

Because it is difficult to obtain information on the clinical extent of disease and treatment from PBCRs, the hospital database was used for such analysis. The majority of breast and cervix uteri cancers were diagnosed at a locally advanced stage. Chemoradiation was the most common type of treatment of cancer cervix uteri. A multi-institutional study from India on cervix cancer showed significantly better survival with chemoradiation than radiation alone in the locally advanced stage. A study from Chennai showed that concurrent chemoradiation for locally advanced cervical cancer resulted in the best disease-free survival. Two thirds of the patients with cancer were diagnosed at the locoregional stage for head and neck cancers from HBCRs. Similar to that, a low proportion of patients with head and neck cancer presented in the early stage, and a high proportion (88.1%) were seen in Uttarakhand. Multimodality was the most common treatment given for breast and head and neck cancers. A multi-institutional study estimated that 65% of new head and neck cancers with locally advanced disease did not receive the benefit of optimal treatment, resulting in poor survival. Less than one fifth of lung and stomach cancers were diagnosed as localized only. Systemic therapy was the most common type of treatment given for lung and stomach cancer. A previous report on HBCR results showed similar findings. A hospital-based study from northern India showed that 90% of patients with lung cancer were diagnosed at an advanced stage of the disease, and there was a delay in diagnostic evaluation and treatment. Creating cancer awareness, preventing risk factors, and improving access to care among people would result in downstaging of cancer.

The measure of validity, MV%, was above 77% for all the PBCRs. Varying patterns of DCO% and M:I% were observed among PBCRs which were dependent on the quality of death registration and certification. Efforts to improve the quality are always underway. In some registries, low DCO% (< 1%) is due to nonavailability of all-cause mortality data and incomplete/incorrect certification of cause of death. Some registries had an efficient trace back procedure by house visit/phone. Data from PBCRs were regularly published in successive volumes of Cancer Incidence Patterns and Burden in India Under NCRP.

| Site                                | Male Patients | CR | Cum Risk   | Female Patients | CR | Cum Risk   | Both Sexes Patients | CR | Cum Risk   |
|-------------------------------------|---------------|----|------------|----------------|----|------------|---------------------|----|------------|
| Ureter and other urinary organs     | 436           | 0.1| 1 in 10,843| 205            | 0.0| 1 in 21,892| 641                 | 0.0| 1 in 14,531|
| Eye and orbit                       | 1,304         | 0.2| 1 in 6,870 | 953            | 0.1| 1 in 9,063 | 2,257               | 0.2| 1 in 7,792 |
| Brain and other nervous system      | 19,979        | 2.8| 1 in 341   | 12,750         | 1.9| 1 in 546   | 32,729              | 2.3| 1 in 419   |
| Endocrine system                    | 9,263         | 1.3| 1 in 709   | 26,665         | 3.9| 1 in 279   | 35,928              | 2.5| 1 in 402   |
| Thyroid                             | 8,570         | 1.2| 1 in 759   | 26,095         | 3.8| 1 in 285   | 34,665              | 2.5| 1 in 416   |
| Adrenal gland                       | 693           | 0.1| 1 in 10,797| 570            | 0.1| 1 in 14,053| 1,263               | 0.1| 1 in 12,209|
| Lymphoma                            | 32,695        | 4.5| 1 in 197   | 20,247         | 2.9| 1 in 296   | 52,942              | 3.8| 1 in 236   |
| Hodgkin lymphoma                    | 7,294         | 1.0| 1 in 1,150 | 3,936          | 0.6| 1 in 1,871 | 11,230              | 0.8| 1 in 1,418 |
| Non-Hodgkin lymphoma                | 25,344        | 3.5| 1 in 238   | 16,263         | 2.4| 1 in 352   | 41,607              | 3.0| 1 in 284   |
| Malig Imn Prol D                    | 57            | 0.0| 1 in 101,774| 48             | 0.0| 1 in 164,355| 105                 | 0.0| 1 in 126,050|
| Multiple myeloma                    | 10,725        | 1.5| 1 in 465   | 7,756          | 1.1| 1 in 646   | 18,481              | 1.3| 1 in 541   |
| Leukemia                            | 32,481        | 4.5| 1 in 239   | 21,132         | 3.1| 1 in 353   | 53,613              | 3.8| 1 in 284   |
| Lymphoid leukemia                   | 14,159        | 2.0| 1 in 608   | 7,419          | 1.1| 1 in 1,138 | 21,578              | 1.5| 1 in 789   |
| Myeloid leukemia                    | 14,913        | 2.1| 1 in 474   | 11,275         | 1.6| 1 in 617   | 26,188              | 1.9| 1 in 536   |
| Leukemia uns                        | 3,409         | 0.5| 1 in 2,287 | 2,438          | 0.4| 1 in 2,980 | 5,847               | 0.4| 1 in 2,583 |
| Other and unspecified primary sites | 48,554        | 6.7| 1 in 114   | 36,976         | 5.4| 1 in 153 | 85,530              | 6.1| 1 in 131   |

Abbreviations: CR, crude rate; cum risk, cumulative risk of developing cancer at 0-74 years of age; Malig Imn Prol D, malignant immunoproliferative diseases; Uns, unspecified.
in Five Continents (CI-5) by WHO-IACR/IARC. The incidence data from 15 PBCRs under NCRP (India) were published in Cancer Incidence in Five Continents, Volume XI, by WHO-IACR/IARC.36-38

The projected incidence of patients with cancer is higher for females (712,758) than males (679,421) for the year 2020. The projected national cancer incidence burden in 2020 will be 98.7 per 100,000 population (1,392,179 patients) as a conservative estimate. It is assumed that the observed rate of 2012-2016 will remain unchanged until 2020. The time trend in rate was not used to avoid uncertainty in the projection for a populous country like India. NCRP has estimated a slightly higher number of patients with cancer compared with IACR/IARC and GLOBOCAN for all sites of cancer in 2018. This may be because of a difference in methodology and use of recent data (1,392,179 vs 1,157,294).22 This is the first such attempt in the country and will be further updated on availability of the next data set and census information. The influencing factors, such as risk factors/behavior, case finding procedure, screening program, and improved techniques for detecting patients with cancer, are likely to influence the projected number of patients.

PBCRs in this study covered 100 million average annual person-years, accounting for coverage close to 10% of the population in India. Cancer registration in India faces several challenges because it is not a notifiable disease, posing challenges to data collection.39-42 The mortality registration system has several gaps, including incomplete and inaccurate certification of cause of death.43,44 Registering through passive notification by health care providers to report cancer occurrence in India would improve the coverage with limited resources. Linking of cancer registry data with Ayushman Bharat,45 mortality databases, and the Hospital Information System would improve cancer registration, follow-up, and outcome data.

This study provides a framework for assessing the status and trends of cancer in India. This shall guide appropriate support for action to strengthen efforts to improve cancer prevention and control to achieve the National NCD targets and the sustainable development goals.36,47 The data also provide leads to key research questions.

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AUTHORS’ DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

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No potential conflicts of interest were reported.

ACKNOWLEDGMENT

The authors acknowledge the contribution of the 28 population-based cancer registries and 58 hospital-based cancer registries under the National Cancer Registry Program, which contributed data, and Research Area Panel Expert Group on Cancer.

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APPENDIX

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