Original Article

Descriptive epidemiology of prostate cancer in India, 2012–2019: Insights from the National Cancer Registry Programme

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ABSTRACT

Purpose: This study describes the epidemiology, clinical extent at diagnosis, and treatment modalities for prostate cancer in India.

Methodology: This study is a secondary analysis of primary prostate cancer data sourced from the National Cancer Registry Programme. Data from population-based cancer registry for the period 2012–2016 were used to estimate the incidence rates, including crude incidence rate (CR), age-adjusted incidence rate (AAR), age-specific rate, and cumulative risk. Trends in the AAR were assessed using join-point regression. Hospital-Based Cancer Registry data from 2012 to 2019 were used to describe the clinical extent of the cancer at diagnosis and the treatment modalities.

Results: The incidence of prostate cancers was higher in urban registries such as Delhi, Kamrup Urban, and Mumbai (AAR of 11.8 per 100,000, 10.9 per 100,000, and 9.7 per 100,000, respectively). Prostate cancer incidence showed a rise after the age of 50, with a notable acceleration after age 64. The overall annual percentage change for prostate cancer incidence from 1982 to 2016 was 2.6. Around 43.0% of all prostate cancers were diagnosed at the distant metastatic stage. Surgery and radiotherapy, either as standalone treatments or in combination with other modalities, contributed to the treatment of 78.5% of localized cancer, 74.2% of locoregional cancer, and 57.2% of distant metastatic stage of prostate cancer.

Conclusion: There is heterogeneity in the incidence of prostate cancer, as evidenced by urban registries. Additionally, there is a need for downstaging the disease, without risking overdiagnosis.

INTRODUCTION

Prostate cancer, is the world's second most common cancer among men. It accounts for approximately 14.2% of new cancer cases in men, with an age-adjusted incidence rate of 29.4 per 100,000 population.[1] Regions such as North America, Europe, and Australia exhibit higher incidence rates of prostate cancer, compared to Asia and Africa.[1,2] The higher incidence of prostate cancer may be attributed to either a genuine increase in disease occurrence or to more frequent screening tests being conducted in asymptomatic men. The established risk factors for prostate cancer include advanced age, black ethnicity (notably observed in certain regions such as the United States), and a family history of the disease. However, convincing level of evidence linking diet (including dairy products and meat), nutrition (such as calcium and energy intake), physical factors (such as height, weight, and energy expenditure), environmental factors (including pesticide and chemical exposures), and behavioral factors (such as smoking and alcohol consumption) with the risk of prostate cancer is lacking.[2,3] Increased awareness and access to care, on the other

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hand, lead to more case detection.[4] The widespread use of prostate-specific antigen (PSA) for screening and early diagnosis played a crucial role in the increase of prostate cancer cases, as indicated by fluctuations in prostate cancer incidence over time in response to PSA advocacy and restriction.[5,6]

Prostate cancer is regarded as a cancer with a relatively high survival, characterized by a low age-standardized mortality rate of 7.7 per 100,000 men/population. However, low- and middle-income regions of South America, the Caribbean, and sub-Saharan Africa have higher mortality rates. Several factors contribute to this trend, including lower screening practices, the biological nature of the tumor, and limited access to health-care facilities for diagnosis and treatment.[2]

Asia has the lowest incidence and mortality rates for prostate cancer, with an age-adjusted incidence rate of 12.6 and a mortality rate of 3.8 per 100,000 persons as of 2022.[1] Despite the low incidence rate, the rate has been increasing in the Asian countries over the past decade, including India.[7,8] In India the landscape of prostate cancer has undergone significant transformation. In 1990, prostate cancer ranked as the 11th most common cancer among males, with an age-adjusted incidence rate (AAR) of 2.5 (per 100,000) annually.[9] Recent data from the National Cancer Registry Programme (NCRP) indicates a significant escalation, projecting prostate cancer to ascend to the third most common cancer among Indian males by 2022, with an estimated incidence rate of 6.8 (per 100,000) and a cumulative risk of 1 in 125 men.[8] The current burden of prostate cancer in India is substantial, with an age-adjusted years lived with disability (YLD) of 6.5 per 100,000 males, ranking third highest among males, and an age-adjusted disability-adjusted life year of 46.9 per 100,000 males, ranking it as the seventh highest among males.[10] The burden of prostate cancer in India is expected to rise further due to population growth, increasing life expectancy, and an increase in the proportion of aging males in the country. It is expected to reach 47,068 incident cases by 2025.[8]

The previous study on the epidemiology of prostate cancer in India relied on older data and was limited in scope, primarily focusing on trend analysis and drawing from a restricted number of registries.[11] This NCRP-based national-level descriptive study on prostate cancer epidemiology aims to identify the pattern of distribution of prostate cancer across the country, trends in incidence, clinical extent of illness, and treatment modalities received by the patients. This more detailed epidemiological picture of prostate cancer in India will help clinicians and stakeholders develop effective strategies to manage the rising public health concern posed by prostate cancer effectively.

METHODOLOGY

Data source

The NCRP, coordinated by the Indian Council of Medical Research-National Centre for Disease Informatics and Research (NCDIR)-Bengaluru, India, serves as the primary data source. Cancer incidence and geographical distributions are estimated from population-based cancer registries (PBCRs), which actively identify and collate cancer cases among individuals residing in the defined registry area for at least 1 year before diagnosis, utilizing data from multiple sources.[12,13] Data are collected by trained investigators from medical records and entered into a standardized format developed by the NCRP in compliance with international standards.[14] These data are digitized using locally developed software and undergo meticulous data cleaning at the NCDIR before consolidation. As of 2022, 38 PBCRs were operating under NCRP, encompassing 16% of the Indian population (comprising complete urban registries: 31.6%, complete rural registries: 9.5%, and urban–rural combination registries: 58.9%).[8]

Estimations regarding the clinical stage of the disease at diagnosis and treatment modalities received were drawn using Hospital-Based Cancer Registry (HBCR) records. HBCRs compile data on cancer patients treated across various departments within a single hospital, irrespective of their residence. After consultation with the relevant oncologist, trained registry staff extract this information from the concerned medical documents. The NCRP tracks all new cases of all cancer sites using PBCRs and HBCRs. For this study, all primary prostate cancer cases registered in the 28 PBCRs from 2012 to 2016 and 91 HBCRs from 2012 to 2019 were included. These 28 PBCRs account for 10% of the Indian population, with 3.5% being completely rural, 42.9% purely urban, and 53.6% of rural–urban combinations.[8] The International Classification of Diseases, Tenth Revision was used to document anatomical characteristics.[15]

Statistical analysis

The PBCR data were used to produce the following measures: (i) crude incidence rate (CR) and (ii) age-adjusted incidence rate (AAR) based on the World Standard Population,[16] (iii) age-specific incidence rate (ASpR), (iv) cumulative risk. The definition of the statistical measures used in the study has been given in the Box 1.

The mid-postcensal population projections for 2012 and 2016 were calculated using the Indian Census of male populations from 2001 to 2011.[17] Trends in AAR for prostate cancer were examined using registry data from 1982 to 2016 for five PBCRs with at least four decades of consistent data. The trends in the AAR for prostate cancer were also examined by age group. The National Cancer Institute (USA) join-point regression trend analysis program was used to

Box 1: Definition of statistical measures estimated in the study

Statistical term	Definitions
CR	Refers to the rate obtained by division of the total number of new cancer cases by the corresponding estimated population (mid-year) and multiplying by 100,000
ASpR	Refers to the rate obtained by division of the total number of new cancer cases by the corresponding estimated population in that age group and gender/site/geographic area/time and multiplied by 100,000
AAR	It is a statistical measure used in epidemiology to compare the occurrence of a particular disease or condition across different populations while accounting for differences in age distributions. It standardizes the incidence rate by adjusting for age, allowing for a fair comparison between populations with different age structures
Cumulative risk	Cumulative risk is expressed as the number of newborn children (out of 100) who would be expected to develop/die from a particular cancer over a lifetime (commonly defined for the age range 0–74 years), assuming that they had the rates of cancer observed in the period of observation and that there is an absence of competing causes of death

CR=Crude incidence rate, ASpR=Age-specific incidence rate, AAR=Age-adjusted incidence rate

calculate annual percentage change (APC) for the specified time periods.[18] Data from HBCRs were examined to ascertain the proportion of clinical extension of cancer at diagnosis and the corresponding treatment modalities. Tumors having their extension within the primary site organ without any lymph node involvement were categorized as localized. Tumors with a direct extension to neighboring sites or involvement of regional lymph nodes or both were considered locoregionally extended. Cases with extensive disease involving distant sites or distant lymph nodes before treatment were labeled as advanced stages.[19]

RESULTS

Incidence rate

Among total 11,340 prostate cancer cases registered in 28 PBCRs during the period of 2012–2016, 77.5% of cases were from purely urban registries (12 registries), and around 17.2% of cases were from six predominant urban registries (>40% urban). Notably, urban registries such as Delhi (AAR: 11.8 per 100,000), followed by Kamrup Urban (AAR: 10.9 per 100,000) and Mumbai (AAR: 9.7 per 100,000), showed the highest AAR, whereas all Northeastern registries (except Kamrup urban) reported relatively lower AAR. The cumulative risk of getting prostate cancer was 1 in 42 persons for Delhi, followed by 1 in 47 persons for Kamrup Urban. In contrast, the risk was low in West Arunachal, with a cumulative risk of 1 in 462 per person [Table 1].

The ASpR for prostate cancer started to rise after the age of 50 and increased further as age increased [Figure 1]. The mean age at diagnosis of prostate cancer in India was 71 years. Registries with higher AAR showed an early rise in ASpR compared to registries with lower AAR [Figure 2 and Supplementary Table 1].

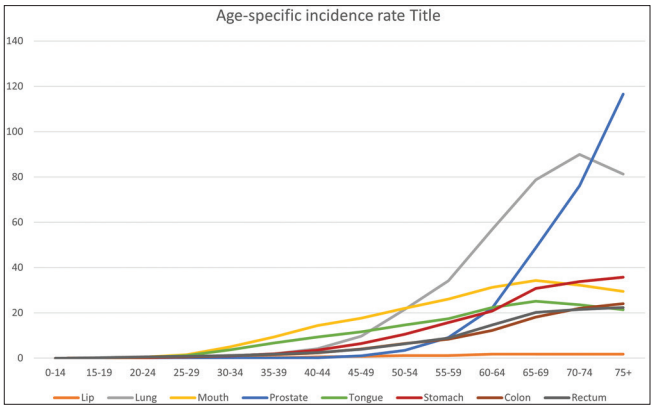

Figure 1: Estimated age-specific incidence rate of leading cancer sites among males for 28 population-based cancer registries under National Cancer Registry Programme 2012–2016

Incidence trends

Trends in the incidence rate of prostate cancer over the years (1982–2016) showed an increasing trend with a pooled APC of 2.6. In terms of growth, Chennai was followed by Delhi, Bangalore, and Mumbai [Figure 3]. Trends in the incidence rate from the recent period (2000–2016) also revealed a similar pooled significant annual percentage rise of 2.6%, coinciding with advancements in prostate cancer diagnosis [Supplementary Figure 1]. There was a significant increase in prostate cancer incidence in the <50-year age group, and the highest APC occurring among those aged over 70 [Figure 4].

Clinical extent of disease at diagnosis

A total of 9547 cases were registered from HBCRs during the period of 2012–2019. Most prostate cancers were diagnosed at the advanced stage (42.9%, n = 4095 cases), followed by localized (29.9%, n = 2855 cases) and locoregional (27.0%, n = 2597 cases) stages of cancer. Notably, the proportion of advanced-stage presentation was higher among the younger age group (<50 years) compared to other age groups (>50 years) [Figure 5]. Adenocarcinoma constituted most histological subtypes (92%) [Supplementary Table2].

Treatment modality

Supplementary Figure 2 provides detailed information on the distribution of treatment modalities for different stages of cancer. For localized stage cancer, surgery was the most common treatment, utilized in 30.3% of cases (865 cases). This was followed by systemic therapy, used in 21.5% of cases (614 cases), and a combination of systemic therapy with radiotherapy, used in 18.5% of cases (528 cases). Radiotherapy alone was employed in 16.4% of cases (468 cases), while the remaining 13.0% of cases were treated with other combinations of modalities. In the locoregional stage of cancer, systemic therapy was

Table 1: Total number of prostate cancers registered with incidence rate per 100,000 and cumulative rate (0–74 years) for 28 population-based cancer registries under the National Cancer Registry Programme 2012–2016

Registry	State	*n* (%)	CR	AAR	Cumulative risk (0-74)
Ahmedabad urban	Gujarat	511 (3.5)	3.1	4.1	1 in 124
Aurangabad	Maharashtra	61 (3.2)	1.8	2.7	1 in 184
Bangalore	Karnataka	847 (6.4)	6.2	8.7	1 in 57
Barshi rural	Maharashtra	43 (5.9)	3.2	2.6	1 in 194
Bhopal	Madhya Pradesh	155 (4.3)	3.6	5.0	1 in 101
Cachar district	Assam (NE)	59 (1.3)	1.3	1.8	1 in 309
Chennai	Tamil Nadu	901 (6.2)	7.6	7.9	1 in 61
Delhi	Delhi	2020 (6.5)	7.3	11.8	1 in 42
Dibrugarh district	Assam (NE)	47 (1.9)	1.3	2.0	1 in 253
Hyderabad district	Telangana	241 (4.7)	3.9	5.5	1 in 94
Kamrup urban	Assam (NE)	270 (4.3)	8.3	10.9	1 in 47
Kolkata	West Bengal	698 (6.9)	7.5	6.1	1 in 81
Kollam district	Kerala	560 (5.6)	9.0	7.1	1 in 70
Manipur state	Manipur (NE)	67 (1.8)	0.9	1.3	1 in 381
Meghalaya	Meghalaya (NE)	33 (0.7)	0.7	1.5	1 in 312
Mizoram state	Mizoram (NE)	73 (1.7)	2.5	3.8	1 in 122
Mumbai	Maharashtra	2148 (8.2)	8.0	9.7	1 in 50
Nagaland	Nagaland (NE)	12 (0.9)	0.6	1.4	1 in 363
Nagpur	Maharashtra	145 (2.4)	2.2	2.6	1 in 205
Osmanabad and Beed	Maharashtra	169 (4.6)	1.8	1.6	1 in 324
Pasighat	Arunachal Pradesh (NE)	9 (2.8)	2.5	4.0	1 in 131
Patiala district	Punjab	340 (6.3)	6.4	6.9	1 in 75
Pune	Maharashtra	856 (8.8)	6.0	8.1	1 in 59
Sikkim state	Sikkim (NE)	20 (1.7)	1.2	1.6	1 in 320
Thiruvananthapuram district	Kerala	945 (7.0)	11.9	9.5	1 in 52
Tripura state	Tripura (NE)	91 (1.4)	0.9	1.2	1 in 457
Wardha district	Maharashtra	99 (4.1)	2.9	2.5	1 in 200
West Arunachal	Arunachal Pradesh (NE)	10 (0.8)	0.5	1.2	1 in 462

n=Number of prostate cancer cases, CR=Crude incidence rate, AAR=Age-adjusted incidence rate, NE=Northeastern registries

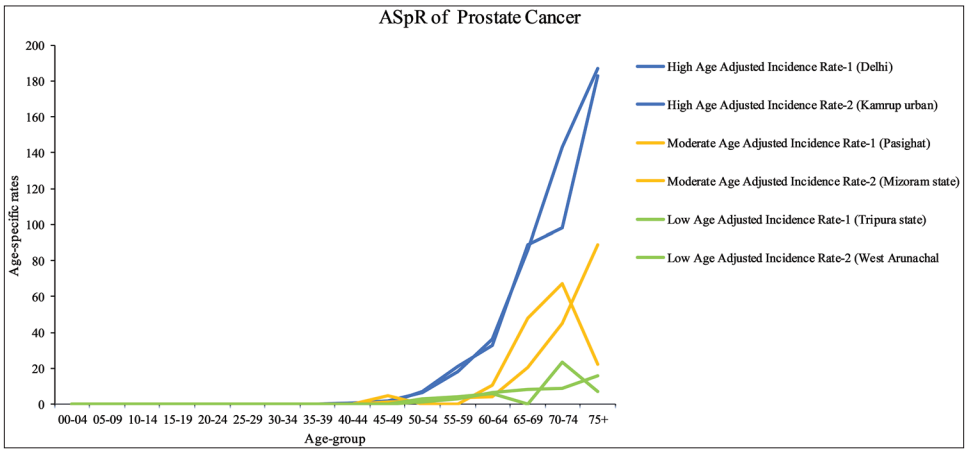

Figure 2: Age-specific incidence rate per 100,000 of the prostate cancer from registries with high, moderate, and lower age-adjusted incidence rates. ASpR = Age-specific incidence rate

the primary treatment modality, used in 25.8% of cases (670 cases). This was followed closely by a combination of systemic therapy and radiotherapy, used in 23.8% of cases (618 cases). Surgery alone was the treatment in 22.2% of cases (577 cases), and radiotherapy alone was used in 12.7% of cases (330 cases). The remaining 15% of cases were treated with other combinations of treatment modalities. For patients with distant metastasis, systemic therapy was the predominant treatment, used in 42.8% of cases (1753 cases). This was followed by a combination of systemic therapy and radiotherapy, used in 16.1% of cases (659 cases). Surgery alone was utilized in 14.1% of cases (577 cases), and radiotherapy alone was used in 10.3% of cases (422 cases). The remaining 16.7% of cases were treated with other combinations of treatment modalities. Systemic therapy in this context encompasses both hormonal therapy and chemotherapy.

DISCUSSION

Prostate cancer ranks as the third leading cancer site among males in India, following lung cancer and mouth cancer. It

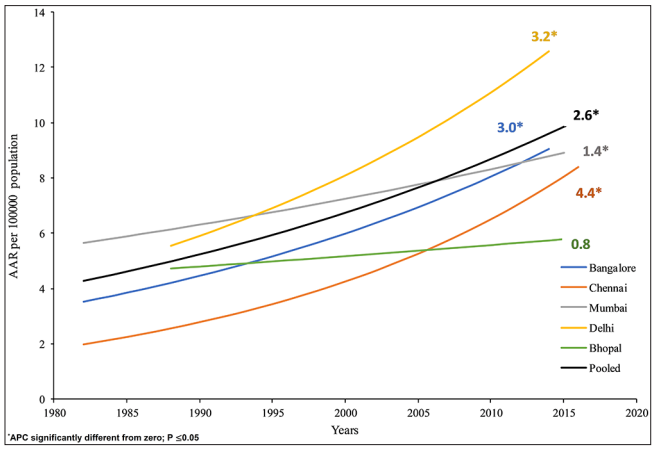

Figure 3: Trends in age-adjusted incidence rate for prostate cancer over the period (1982–2016) in selected 5 population-based cancer registries with the pooled value. APC = Annual percentage change, AAR = Age-adjusted incidence rate,* indicates the statistical significance

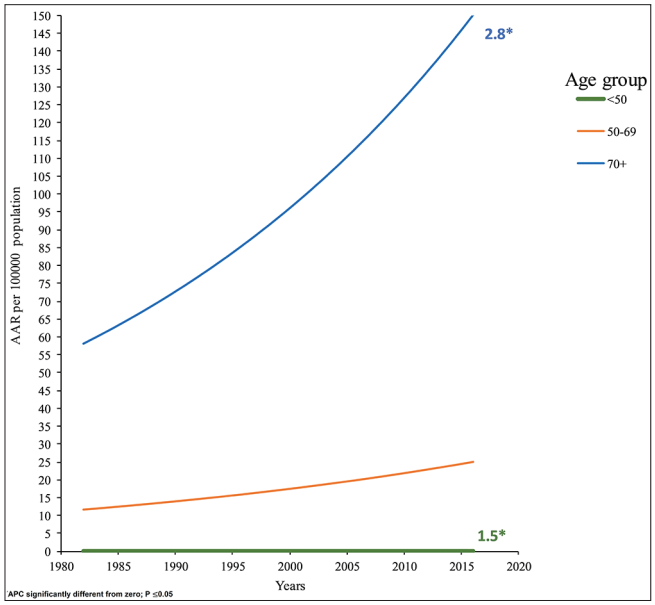

Figure 4: Trends in the age-adjusted incidence rate of prostate cancer by age group wise over a period of time from all 5 selected population-based cancer registries. APC = Annual percentage change, AAR = Age-adjusted incidence rate,* indicates statistical significance

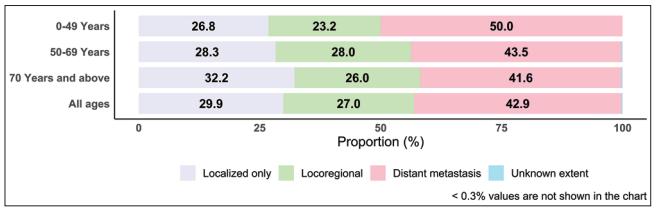

Figure 5: Proportion of prostate cancer according to clinical extent of disease before treatment in age group wise and all ages together from 91 hospital-based cancer registries (2012–2019)

accounts for 6.1% of all male cancer incidence in India as estimated for the year 2022.[8] The age-adjusted incidence rate of prostate cancer varies from 11.8 per 100,000 persons in Delhi to 1.2 per 100,000 persons in West Arunachal Pradesh. The incidence is high among urban and predominantly urban registries (>40% Urban) whereas predominantly rural registries such as Barshi, Wardha, Osmanabad, and Beed as well as many Northeastern registries reported lower incidence rates. There exists a positive correlation (0.65) between cancer incidence and the proportion of urban coverage in the registries [Supplementary Table 3]. This urban phenomenon of prostate cancer has also been observed in studies conducted in China.[2,20] The reasons may include factors such as increased rural-to-urban migration, altered dietary and lifestyle habits, increased awareness, and improved access to medical facilities in urban areas. Additionally, there may also be underreporting of cases from rural areas.[21-23]

The incidence of prostate cancer has demonstrated an upward trajectory over time, exhibiting a notable APC of 2.6%. This figure represents a pooled average derived from data collected across five registries spanning the years 1982–2016. In 1988, the AAR of prostate cancer in Mumbai, Delhi, Bangalore, Chennai, and Bhopal was 6.3 per 100,000 persons, 5.8 per 100,000 persons, 5.1 per 100,000 persons, 2.5 per 100,000 persons, and 2.2 per 100,000 persons, respectively. This increasing trend of prostate cancer has also been noted in various registries as mentioned in other studies.[11,23] Decadal changes in the ranking of prostate cancer between 1990-1996 and 2012-2016 further demonstrate an increase in the incidence rates in both rural and urban registries [Supplementary Table 4]. While the APC was nonsignificant in the Bhopal registry (APC 0.8%), it was notably high in Chennai (APC 4.4%). One of the reasons to this disparity could be the percentage change in the older population proportion. For instance, in Chennai, the percentage change in the population aged 50 and above increased from 13.7% in the 1991 census to 19.3% in the 2011 census, representing a 5.6% increase. Whereas, for Bhopal, this percentage increased from 10.8% to 13.9% (an increase of 3.1%).[17,24] Lower screening practices for prostate cancer have been observed in Central India suggesting a need for further investigation into potential underreporting or missed detection in this region.[25] Similarly, while the incidence is increasing in the elderly age group, significant growth has been observed in the individuals younger than 50 years old. There was an early onset of prostate cancer (before 60 years of age) in registries with higher incidence rate, which may be attributed to genetic factors, early exposure to risk factors, or the practice of PSA-based screening warranting further exploration.

In India, although the incidence and mortality rates for prostate cancer are relatively lower compared to Western and European countries, the ratio of mortality to incidence rate is higher [Supplementary Table 5]. Prostate cancer in India is diagnosed mainly in its advanced stage. Notably a higher proportion of distant metastasis (42.9%) were found in patietns in India, compared to the USA (8.0%)

and Norway (8.9%) [Supplementary Figure 3]. Previous studies from India have reported an even higher proportion of late-stage diseases.[26,27] The reason for the delayed presentation could be a lack of awareness, limited access to care, and absence of routine screening practices. Additionally, the aggressive nature of prostate cancer in the Indian population could contribute to delayed diagnosis.[21,28,29] In contrast, the lower proportion of metastatic prostate cancer in the USA may be the result of active PSA screening done in the country. The evidence regarding effectiveness of population-based screening using PSA in reducing mortality and improving survival rates remains uncertain with concerns about overdiagnosis, treatment-associated morbidities, and overutilization of resources.[2,30-33] There is a common consensus that opportunistic and executive health checkup screenings are viable options to be considered for a country like India for downstaging the disease.[34,35]

The literature regarding prostate cancer diagnosis and management in rural areas is limited. However, some studies have demonstrated the utility of transrectal ultrasound (TRUS) biopsy by urologists in rural settings, yet standardized TRUS-guided 12-core prostate biopsies remain lacking, highlighting the need for further research and infrastructure development in rural health-care settings.[36]

The factors influencing the management of prostate cancer are not only restricted to the clinical extent of the disease but also include PSA value and histopathological grading (Gleason scoring system)[37] Research showed that treatment decisions are influenced by these factors, with surgery and radiotherapy being more commonly applied for localized stage, whereas the application of systemic therapy (including androgen deprivation therapy and chemotherapy) increases as the stage advances. This treatment pattern aligns with findings from other studies where radical prostatectomy and/or radiotherapy are the primary treatment modalities for low- and intermediate-risk localized cases. For high-risk and advanced cases, the application of systemic therapy alone or in combination with radiotherapy increases.[38]

The main strength of the study is the use of extensive and reliable data from 28 PBCRs, providing a comprehensive and generalizable understanding of the prostate cancer burden in the country. However, the study was limited by the lack of detailed prostate cancer-specific clinical data such as PSA levels, Gleason grade group, the type of biopsy, type of surgery, and the involvement of specialists. Additionally, cases managed through active surveillance were recorded in the free text option of "others" which may have led to its underrecording. There were also challenges in classifying the patients into urban and rural for 15 registries (53.6%) that had both components which may have impacted further analysis. Furthermore, there was a lack of representation of data from some of the densely populated states of the country, such as Uttar Pradesh, Rajasthan, and Bihar, which can result in a possible bias in interpretation and generalization.

CONCLUSION

Prostate cancer incidence is increasing among all age groups indicating an emerging public health problem exacerbated by aging population, increased life expectancy, and expanding urbanization. The new estimates presented in this study offer valuable insights for cancer prevention and control activities through the intervention of early detection, risk reduction, and management of prostate cancer in India. However, appropriate research is needed to delve deeper into the reasons for prostate cancer burden focusing on the identification of affordable and accurate diagnosis and management options in the Indian population. Strengthening cancer registration by ensuring the inclusion of more representative population from each state of the country will help in enhancing overall prostate cancer management and policy.

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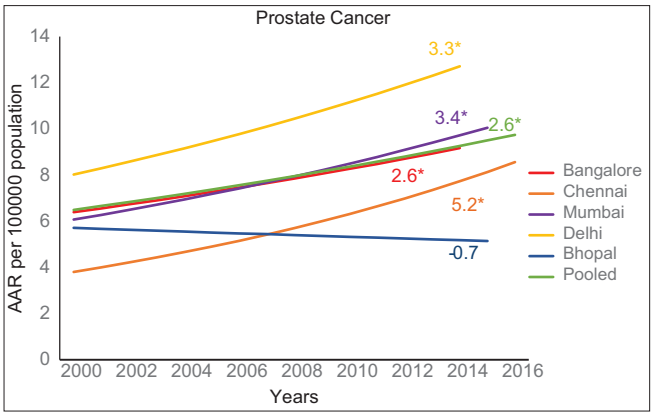
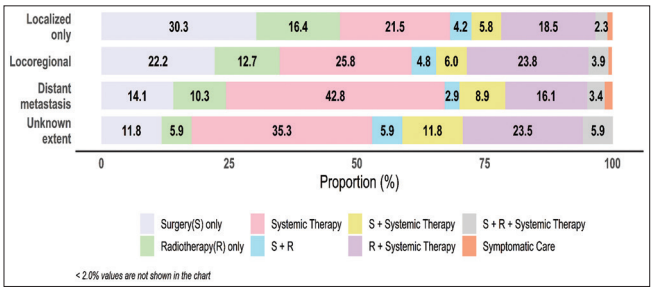
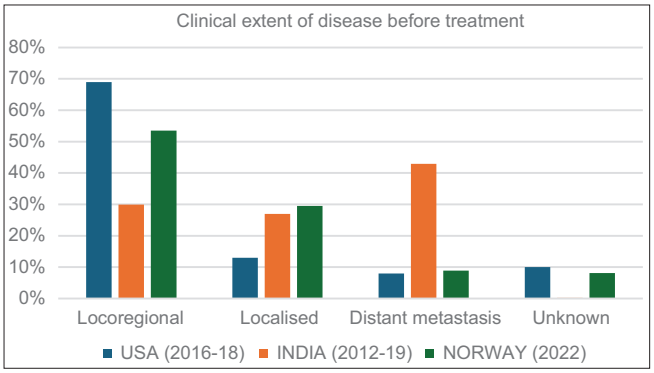


Supplementary Figure 1: Trends in age-adjusted incidence rate for prostate cancer over the period of time (2000–2016) in selected five population-based cancer registries with the pooled value. AAR = Age-adjusted incidence rate



Supplementary Figure 2: Proportion of treatment modalities received among prostate cancer patients at various clinical extents of disease



Supplementary Figure 3: Proportion of clinical extent of disease before treatment compared between India, USA, and Norway. Source: USA: Centers for Disease Control and Prevention. U.S. Cancer Statistics Prostate Cancer Stat Bite. US Department of Health and Human Services; 2023. Norway: https://www.kreftregisteret.no/en/Temasider/Cancers/Prostate-cancer/. India: Clinicopathological Profile of Cancers in India: A Report of the Hospital-Based Cancer Registries, 2021 https://ncdirindia.org/All_Reports/HBCR_2021/Default.aspx

Supplementary Table 1: Age-specific incidence rate of prostate cancer per 100,000 by age group for 28 population-based cancer registries under National Cancer Registry Programme 2012–2016

Registry	ICD-10	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	75+
Delhi	C61	0	0	0	0	0	0	0.1	0	0.4	2	6.2	17.9	36.4	86	143.2	186.9
Kamrup urban	C61	0	0	0	0	0	0	0	0	0.4	0.9	7	21.3	32.6	89.1	98.2	182.7
Mumbai	C61	0	0.1	0	0	0.1	0.1	0.2	0	0.2	0.8	3.1	10.2	28.1	61.5	113.9	188.5
Thi'puram district	C61	0	0	0	0	0	0	0	0.3	0.2	0.8	3.9	11.3	33.8	71.2	112.5	152
Bangalore	C61	0	0	0	0	0	0.1	0	0	0.3	1.1	2.8	11.5	33.3	58.9	93.6	150.8
Pune	C61	0	0	0	0	0	0.1	0.1	0.1	0.3	0.7	2.4	7.6	20	58.6	92.7	158.6
Chennai	C61	0	0	0	0	0	0.1	0.1	0.1	0.1	1.1	3.3	8.7	18.9	59.9	75.8	161.6
Kollam district	C61	0	0	0	0	0	0	0	0.2	0	0.9	4.5	7.2	21.8	60.9	93.1	98.1
Patiala district	C61	0	0	0	0	0.2	0	0.2	0.3	0.3	2.8	8.5	11.1	25.1	45.5	75.1	97.8
Kolkata	C61	0	0	0	0	0	0	0	0	0.4	1	3.7	10.5	17.7	41.8	66.8	107.3
Hyderabad district	C61	0	0	0	0	0	0.2	0	0.6	0.7	0.3	2.6	8.3	25.2	42.5	49.7	83.2
Bhopal	C61	0	0	0	0	0	0	0.3	0.3	1.1	0	2.7	7.7	17	38	55.4	76.1
Ahmedabad urban	C61	0	0	0	0.1	0	0.1	0	0.2	0.2	0.9	2	6.9	15.6	32.1	49.8	53.4
Pasighat	C61	0	0	0	0	0	0	0	0	0	5	0	0	10.6	48.2	67.2	22.3
Mizoram state	C61	0	0	0	0	0	0	0	0	0	1.3	1.6	3.3	4.3	20.4	45.3	88.7
Aurangabad	C61	0	0	0	0	0	0.3	0	0.4	0.4	1.1	1.4	2.8	5.9	19.1	35.9	41.8
Barshi rural	C61	0	0	0	0	0	0	0	0	0	0	3.5	4.5	6.5	17	38.4	33.3
Nagpur	C61	0	0	0	0	0	0	0	0	0	1.1	2.2	4.1	9	23.4	31.4	26.4
Wardha district	C61	0	0	0	0	0	0.3	0	0	0	0	1.1	7.2	9.3	12.2	35	35.3
Dibrugarh district	C61	0	0	0	0	0.3	0	0	0	0	0	1.8	3.3	6.1	14.8	25	27.8
Cachar district	C61	0	0	0	0	0	0	0	0	0	0.8	1.5	7.3	7.8	15.5	13.1	18.8
Osmanabad and Beed	C61	0	0	0	0.2	0	0	0	0	0	0.2	1.3	3.2	7.6	12.5	18.9	17.9
Sikkim state	C61	0	0	0	0	0	0	0	0	0	0	1.3	3.6	2.5	16.3	8.5	30.4
Meghalaya	C61	0	0.1	0.2	0	0	0	0	0	0	0	0.7	4.2	3.8	5.8	13.8	35.6
Nagaland	C61	0	0	0	0	0	0	0	0	0	0	1.5	2.2	9.1	0	14.9	27.5
Manipur state	C61	0	0	0	0	0	0	0	0	0	0	0.9	0.8	3.8	9.4	16.9	20.7
Tripura state	C61	0	0	0	0	0	0	0	0.1	0.1	0.3	1.2	2.9	6.2	8.3	9	15.7
West Arunachal	C61	0	0	0	0	0	0	0	0	0	0	2.7	4.3	5.7	0	23.6	7

Thi'puram district - Thiruvananthapuram district. ICD-10=International Classification of Diseases, Tenth Revision

Supplementary Table 2: Number and proportion (%) of prostate cancer according to broad histological classification

Broad histological classification	*n* (%)
Epithelial tumors	
Adenocarcinoma, NOS	7207 (77)
Acinar cell carcinoma	1416 (15.1)
Transitional cell carcinoma	31 (0.3)
Squamous cell carcinoma	48 (0.5)
Carcinoma, NOS	434 (4.6)
Neuroendocrine tumors	
Neuroendocrine tumors	52 (0.6)
Mesenchymal tumors	
Mesenchymal tumors	31 (0.3)
Others	148 (1.6)
Total	9367 (100)

Source: For web-based downloads: Clinicopathological profile of cancers in India: A report of the hospital-based cancer registries, 2021 https://ncdirindia.org/All_Reports/HBCR_2021/Default.aspx. NOS=Not otherwise specified

Supplementary Table 3: Correlation between urban proportions and age-adjusted incidence rate from 28 population-based cancer registries under National Cancer Registry Programme report 2012–2016

Registries	AAR	Urban percentage
Ahmedabad urban	4.1	100
Aurangabad	2.7	100
Bangalore	8.7	100
Barshi rural	2.6	0
Bhopal	5	100
Cachar district	1.8	18.2
Chennai	7.9	100
Delhi	11.8	100
Dibrugarh district	2	18.4
Hyderabad district	5.5	100
Kamrup urban	10.9	100
Kolkata	6.1	100
Kollam district	7.1	45
Manipur state	1.3	29.2
Meghalaya	1.5	24.9
Mizoram state	3.8	52.1
Mumbai	9.7	100
Nagaland	1.4	49.3
Nagpur	2.6	100
Osmanabad and Beed	1.6	18.7
Pasighat	4	25.4
Patiala district	6.9	40.3
Pune	8.1	100
Sikkim state	1.6	25.2
Thiruvananthapuram district	9.5	53.7
Tripura state	1.2	26.2
Wardha district	2.5	32.5
West Arunachal	1.2	25.8

Correlation coefficient=0.65, $P<0.001$. AAR=Age-adjusted incidence rate

Supplementary Table 4: Ranking of Prostate cancer as the leading site in selected population-based cancer registries during 1990–1996 and 2012–2016 time period

Registries	Past ranking (1990–1996)	Recent ranking (2012–2016)
Bangalore	7th	3rd
Chennai	9th	5th
Mumbai	8th	3rd
Delhi	8th	3rd
Bhopal	6th	6th
Barshi	>10th	4th

Source: NCRP report 1990–1996, NCRP report 2012–2016.
NCRP=National Cancer Registry Programme

Supplementary Table 5: Estimated age-adjusted incidence and mortality rate per 100,000 with mortality -incidence ratio for the year 2020 in selected countries

Countries	Age adjusted Incidence rate	Age adjusted Mortality rate	Mortality Incidence ratio
USA	72	8.2	0.11
Brazil	78	13.7	0.18
UK	77.9	12.4	0.16
Japan	51.8	4.5	0.09
World	30.7	7.7	0.25
Jamaica	87.6	37.4	0.43
China	10.2	4.6	0.45
India	5.5	2.7	0.49
Zimbabwe	70.6	41.7	0.59

Source: GLOBOCAN 2020