

Review Article

Cancer Incidence Trends in India

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During the last 20 years, India has emerged as a fast growing economy with changes in lifestyle-related behavior partially responsible for the increasing cancer burden. While cancer incidence rates are lower than many western countries some changes over recent decades have emerged. This paper examines the time trends in cancer-specific incidence from six population-based cancer registries in India and review articles published on cancer trends in the country. The results are examined in light of their implications to cancer prevention and cancer control.

Key words: cancer – time trend – India

INTRODUCTION

In recent years, a mounting body of evidence suggests that increasing wealth, economic opportunities and education have led to better health, an increasing life expectancy and a growing and ageing population. Such global transitions are also associated with less favorable consequences including the increasing prospects of, and accessibility to, unhealthy lifestyle behaviors, including tobacco use, increased consumption of highly calorific foods, and a reduction in physical activity. The cumulative impact of these lifestyle choices on the world's larger and increasingly aged population has led to an increase in the burden of non-communicable diseases in many low- and middle-income countries undergoing human transition including India (1,2).

During the last 20 years, India has emerged as a fast growing economy with changes in lifestyle-related behavior partially responsible for the increasing cancer burden (3); the disease is among top three killers among adults in both rural and urban India (4). Cancer incidence rates, while still lower compared with many western countries have been changing over recent decades (5).

Given this observation, the current study examines the temporal incidence data from India and review articles published on cancer trends in the country, estimating the time trends for some of the most common and rare cancer sites based on available data from population-based cancer registries. The

results are interpreted in light of the implications on cancer prevention and cancer control.

METHODOLOGY

The main source of data to study cancer trends on cancer are population-based cancer registries. The registries included in the analysis are Bangalore, Bhopal, Chennai, Delhi, Mumbai (all urban) and Barshi (rural). The first registry in India was established in Mumbai in 1963 and a major expansion took place from 1982 with the formation of the National Cancer Registry Programme (6). The current study includes the published data from registries which started functioning since 1988 onwards. To study the time trends we have selected most frequent and important cancer sites observed by Indian registries. The sites selected to study trends were mouth (C03–C06), esophagus (C15) lung (C33–34), stomach (C16), colon (C18), rectum (C19–C20) and brain (C70–72) for males and breast (C50) and cervix (C53) for females.

A search was undertaken in MEDLINE (www.pubmed.com) using the *PubMed* database, using key words including 'Cancer Registry', 'India', 'time', 'trends', 'descriptive epidemiology' and their corresponding Mesh terms in combination. The search was limited to the English literature including those studies which were published between 1988 and 2012. The search yielded a total of 14 studies. We also

utilized annual reports published by registries from time to time as well as consolidated *ad hoc* report on time trends published by National Cancer Registry programme during the time period between 1988 and 2005 (7). We calculated age-standardized incidence rates (ASR) using the world standard population and the average annual percentage change (EAPC) on fitting log-linear model to the rates with calendar year as the regressor; statistical significance was considered at $P < 0.05$. The observed ASR by calendar period is displayed on a semi-log scatterplot with locally weighted regression (lowess) curves fitted to provide smoothed lines through the observed ASR.

RESULTS

Figures 1 and 2 show trends in ASR for all cancer sites in males and females, respectively, for cancer registries which in operation for >15 years data. While the trends are difficult to decipher, none of the registry datasets shows very strong upward trends in the ASR over the two decade period for males, while for females non-significant (EAPC = 0.09) upward trends were observed for the rural Barshi and Bhopal (EAPC = 0.21) population. (Figs 1 and 2).

The incidence trends in most common cancer sites for males are shown in Fig. 3 for cancers of the lung, esophagus, stomach, mouth, colon, rectum and brain for six cancer registries. Lung cancer slightly increased in Chennai men, with the ASR increasing from 10.0 in 1988 to 13.0 in the year 2005. Similarly, the Delhi registry showed statistically significant

increases in men for this cancer (EAPC = 1.10) in recent years; other registries showed non-significant declines in the male ASRs.

All six registries showed declines in the male rates of esophageal cancer since 1988. Except for Bangalore and Chennai, the trends for mouth cancer indicate statistically non-significant increases for this neoplasm. In contrast, male stomach cancer incidence declined in the six populations, while rates of colon exhibited statistically significant increases. Statistically non-significant increases were also observed in trends for rectal cancer in Bangalore and Chennai (Fig. 3).

Among women, breast cancer incidence trends have increased in all urban registries in India over the last 20 years; this phenomenon is also seen for the rural population of Barshi (Fig. 4). In contrast, cervical cancer rates are uniformly decreasing in all urban and rural registries (Fig. 4).

The specific studies conducted on time trends in India have reported statistically significant increases for female breast cancer, alongside significant decreases in cervical and mouth cancer, with little change in ovarian cancer (Table 1).

DISCUSSION

We have utilized data from six cancer registries operational in India for >20 years to study the time trend in incidence rates in India. The data from these registries are reasonably reliable

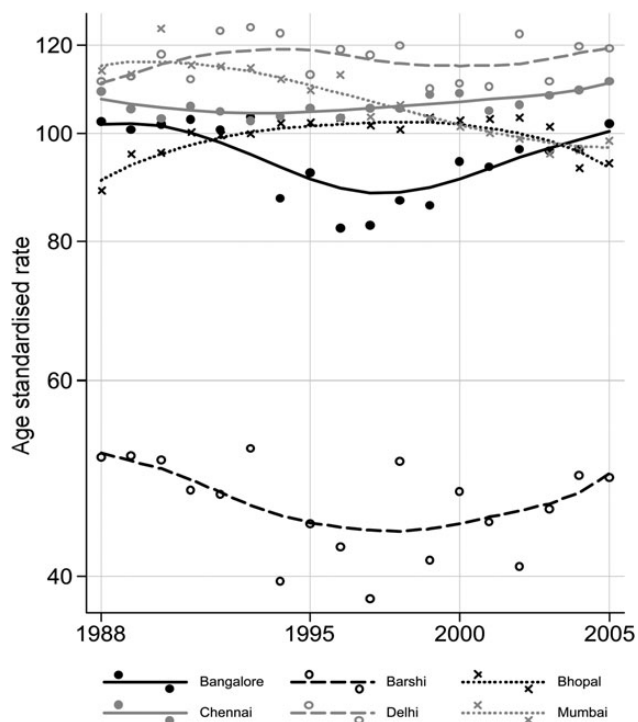


Figure 1. Time trends for all cancer sites combined for selected cancer registries in India. Sex: male.

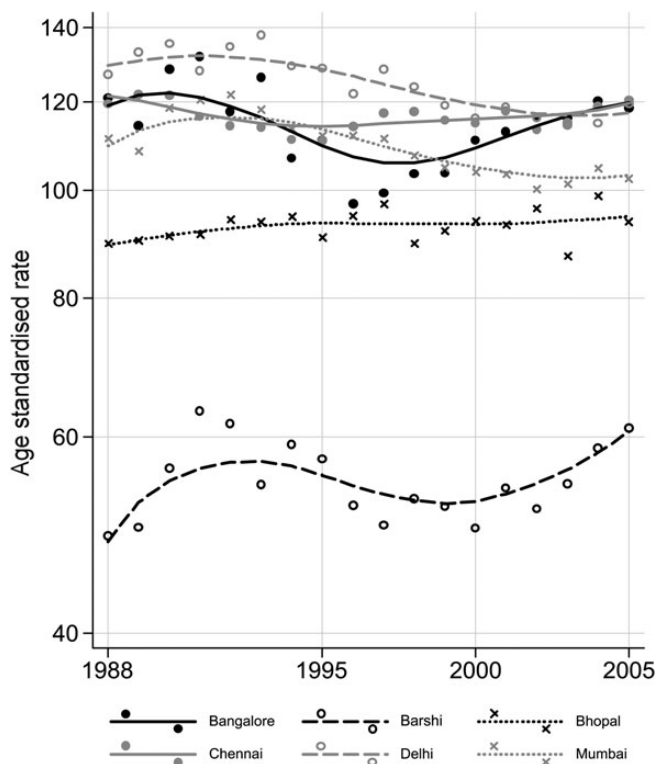


Figure 2. Time trends for all cancer sites combined for selected cancer registries in India. Sex: female.

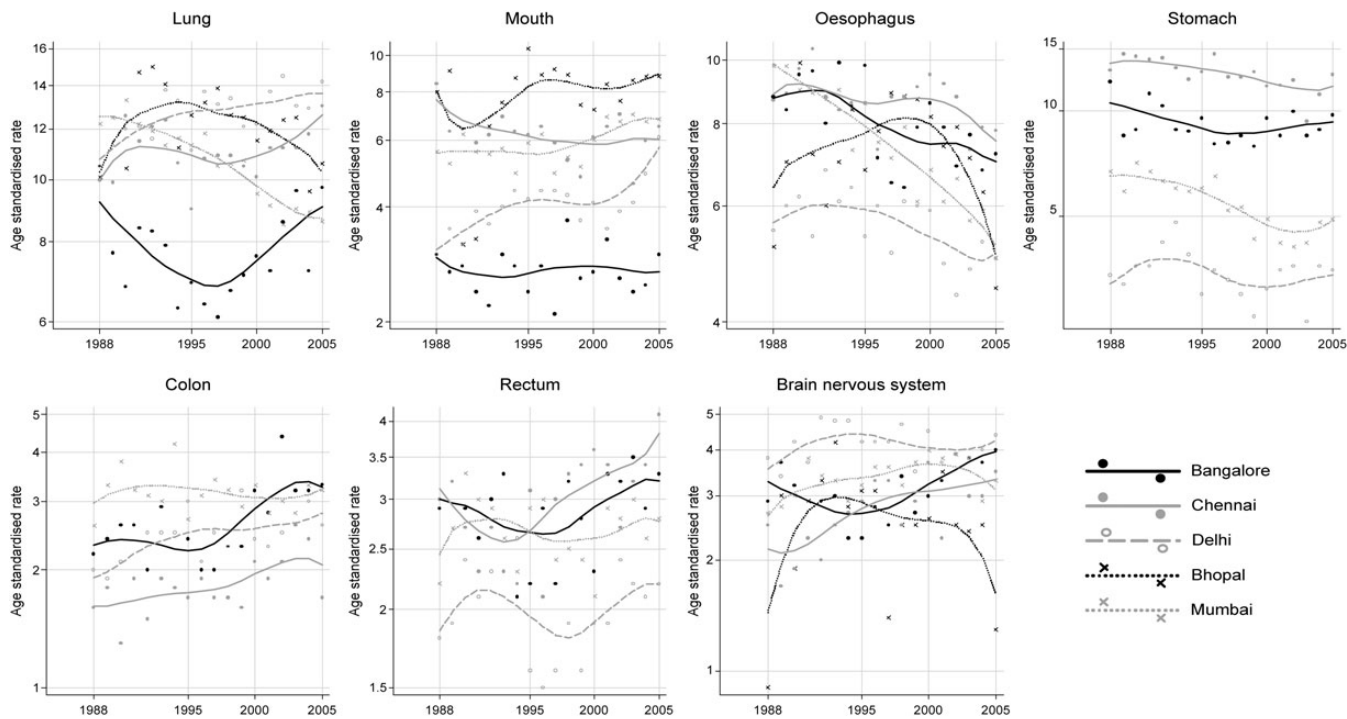


Figure 3. Time trends for all cancer sites combined for selected cancer registries in India Sex: male.

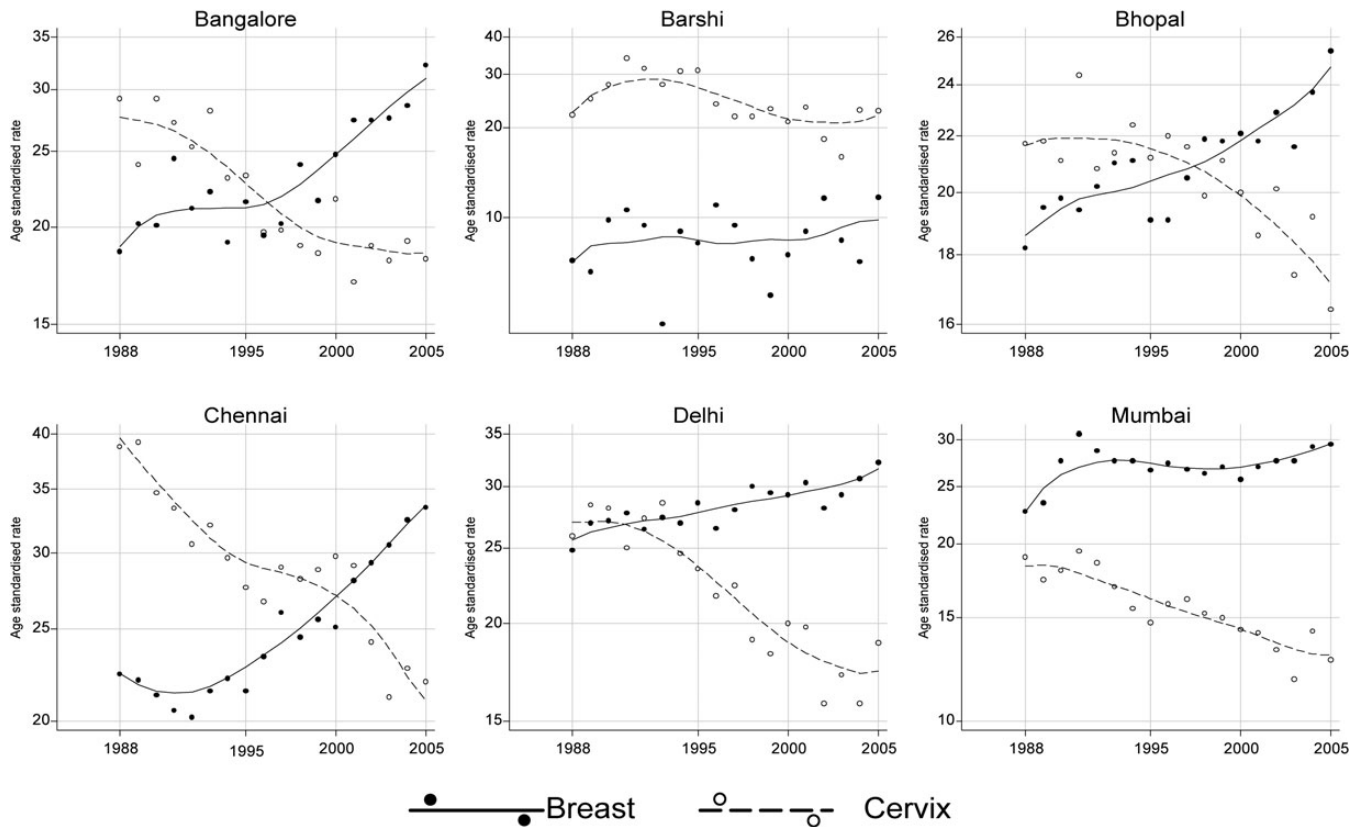


Figure 4. Time trends for breast and cervical cancer selected cancer registries in India.

and complete. The population-based cancer registries of Mumbai and Chennai have also met the criteria for inclusion in successive volumes of the *Cancer Incidence in Five*

Continents series published by International Agency for Research on Cancer (17). The quality indices to assess the quality of data reveal that microscopic verification of cases as

Table 1. Time trends in cancer incidence for selected cancer sites from published literature

Cancer sites	Model fitted	Years considered to study trends	EAPC (95% CI)	Reference
Breast	APC	1976–2005	Below age 50 = 1.0 (95% CI 0.2–1.8) Above age 50 = 1.6 (95% CI = 1.1–2.0)	Dikshit et al. (8)
Breast, cervix, ovary	APC	1976–2005	Breast 1.1 (95% CI = 1.0–1.3) Cervix –1.8 (95% CI = –2.0 to –1.6) Ovary 0.3 (95% CI = –0.1–0.6)	Dhillon et al. (9)
Stomach	Log linear (fitted to age-standardized incidence rate [ASR])	1986–99	–0.5 NS	Sunny et al. (10)
Prostate	Log linear (fitted to ASR)	1986–2000	–0.12 NS	Sunny et al. (11)
Ovary	Log linear	1986–2003	Mumbai = 1.1, Chennai = 0.8 Bangalore = 2.7	Murthy et al. (12)
Oral cancer	Log linear	1986–2000	Male: –1.70 Female: –0.85	Sunny et al. (13)
Lung cancer	Linear regression	1986–2003	Male: –1.1 Female: 1.51	Agarwal et al. (14)
Head and neck cancer	Log linear	1976–2004	Mumbai: –0.85, Bangalore = .04, Chennai = 1.1, Delhi = –0.1, Bhopal = 0.6, Barshi = 1.1	Yeole (15)
Breast and cervix	Joinpoint	1991–2004		Takiar and Srivastav et al. (16)

Table 2. Model used for time trends and their limitations

Models	Reference	Cancer site	Limitation of methods
Linear regression	Takiar and Srivastav (16), Murthy et al. (12)	All cancer sites combined, frequent cancer sites	Crude method for assessing the trends. Distribution of cancer cases assumed to be normal
Log-linear regression	Yeole (15)	Head and neck, rectum	Does not take into account all components of time, i.e. age, period and cohort. If there is a curvature in trend, model gives imprecise and incorrect estimate of average unit change
Joinpoint	Report of NCRP on time trends,	All sites combined, frequent cancer sites	Estimated trend is influenced by last data point. Does not take into account cohort effects. In published report standard error of rates over the years have not been accounted for
Age period cohort	Dikshit et al. (8), Dhillon et al. (9)	Breast, cervix, ovary, CML	Cannot distinguish whether the observed linear trends are due to period or cohort

CML, chronic myloid leukemia.

reported by these registries were high (>80%) and only small proportion of cases were registered by Death Certificate only (<6%). We also reviewed studies in the literature on time trends in cancer incidence in India and only few studies have fitted age, period and cohort models to study the trends so as to understand the cohort and period effects. Most of the studies on time trends conducted in India have used linear regression and joinpoint methods to study temporal patterns and these have not taken into account changes in age-specific rates over calendar time or across successive birth cohorts. The limitations of the various methods used to study time trends in India are tabulated in Table 2.

No significant increases were observed by registries for all sites combined in either sex. However, small but non-significant increases were observed among women in rural Barshi. This suggest that even though there is a rise in the cancer burden—the number of new cancer cases in both sexes

over the last two decades—corresponding incidence rates for all cancer sites combined may not have increased significantly. The most important and clear trends observed are those for female breast and cervical cancer, where an increase in breast cancer in both rural and urban India is met with a decrease in cervical cancer in all populations. The observed trend in breast and cervix cancer was similar in the current analysis study as well as in the trend studies conducted earlier (8,9,16).

The increase in incidence of breast cancer is likely to be the result of changing prevalence and distribution of risk factors that are allied to reproductive, dietary and other lifestyle choices that are correlated with economic growth (18,19). For example, the percentage of woman married by the age of 18 in India has declined from 54.2% in 1992–93 to 44.5% in 2005–06. Similarly parity has reduced from 3.39 live born children per women delivered in 1992–93 to 2.68 by 2005–06 (1). Similarly, significant declines in cervical cancer

Table 3. Summary recommendations for cancer control activities in India

Intervention levels	Middle-to-late transition, moderate-to-high capacity				Very early transition, very low-to-low capacity			
	primary care units /community	District hospital	Medical colleges	RCC	Community	District hospital	Medical colleges	RCC
Identifying disease burden Prevention	Primary Prevention activities in community by health workers in close coordination with other national programme	Tobacco cessation activities*	Tobacco cessation activities. Established population-based cancer registries	Tobacco cessation activities. Education to health workers about primary prevention activities for cancer. Developing population-based cancer registries	Primary prevention activities targeted towards policy makers		Tobacco cessation activities	Developing hospital-based cancer registries
Early diagnosis	Recognition of early cancer cases by health workers in community and appropriate referral. Spread awareness in public about warning signals of cancer		To give training and education to health workers for early recognition of cancer cases	Developing clear referral policy. To give training and education to health workers for early recognition of cancer cases			To give training and education to health workers for early recognition of cancer cases	To give training and education to health workers to enable early detection of cancer cases
Screening	Single life time screening for cervical cancer by visual inspection with acetic acid (VIA). Visual oral screening in high-risk population by health workers for oral cancer	Opportunistic clinical breast exam (CBE) for breast cancer for women in the age group 45–60 years	Opportunistic CBE for breast cancer for women in the age group 45–60 years	Training and education to health workers and doctors for VIA and visual inspection of oral cavity	Nil		Opportunistic screening by VIA for cervical cancer and opportunistic visual inspection of oral cavity	Training and education to health workers and doctors for VIA and visual inspection of oral cavity.
Curative therapy	Follow up of treated cases	Facilities for staging of common cancer sites. Colposcopic facilities. Curative surgery for early-stage breast, cervix, oral cavity cancer. Cobalt therapy facility when Medical college/RCC is far away	Major cancer directed treatment	All cancer directed treatment. Training to Doctors for curative surgery of early-stage breast, cervix and oral cavity cancer			Major cancer directed treatment	All cancer directed treatment
Palliative care	Pain relief and palliative care activities	Pain relief and palliative care activities in community	Pain relief and palliative care activities	Pain relief and palliative care activities. Strengthen research in indigenous system for health care			Pain relief and palliative care activities	Pain relief and palliative care activities

*Primary prevention activities include tobacco control, reduction of alcohol use, promotion of healthy diet and physical exercise, strengthening education on sexual and reproductive factors. RCC, regional cancer centres.

are likely due to changes in marriage and family planning, supported by underlying improvements in education and socioeconomic status. For both, cervical and breast cancer, significant cohort effects have been observed indicating changing prevalence and distribution of risk factors reflected as changes in the rates among successive generations.

Among men, the decline in stomach cancer and the increase in colon cancer confirm that the observed cancer trends in India over the two decades largely reflect the urbanization demographic, epidemiologic and cancer transition, with increasing modernization of India transforming education, lifestyle, access to health care and longevity. The observations of current study are similar to those observed by previous studies (10). Increase in lung cancer rates among males in Chennai and Delhi and an increase in mouth cancers in Bhopal and Mumbai suggest that tobacco control remains priority for cancer control in India.

The current analysis of time trend for breast cancer clearly identifies needs for the control of female breast cancer at the primary, secondary and tertiary level within India. While modification in lifestyle is difficult, prospects for a reduction in disease include the control of obesity and detecting cases at early stages via the promotion of self-breast examination or clinical breast examination after the age of 50 (20,21).

While cervical cancer is declining in urban settings, it is still the leading cancer site among women across India. The decline rates for cervical cancer may be partly explained by greater awareness for genital hygiene, and visiting clinicians at pre-clinical stage. As the rates for cervical cancer are low among Muslims (22), role of male circumcision as a primary prevention method for reducing cervical cancer needs further exploration; circumcision is shown to reduce transmission of Human Papilloma Virus (23), suggesting its possible role in reducing cervical cancer. We have recently demonstrated that screening with visual inspection with acetic acid (VIA) even with trained health workers has the potential to reduce mortality from cervical cancer (24). As VIA screening is a low cost and feasible method to reduce cervical cancer mortality, the logistics to enable nationwide VIA screening should be developed. Other strategies to reduce cervical cancer includes vaccination against human papilloma virus before marriage and for married women, screening with pap smears (25,26). However, both these methods are relatively costly, and logistically challenging.

As lung and oral cancers are the commonest cancer site among males and are showing increasing trends in some registries, tobacco control must be the utmost priority and will reduce not only the tobacco-related cancers but many other chronic diseases (27,28). Implementations of cancer control programme may proceed in a series of stages and each should have clear measurable objectives, representing the basis for the development of next stage, permitting visible and controlled progress. As a first step, cancer control activities in India can be initiated in the states with moderate-to-high capacity. The cancer registries should be a central component of such cancer control programmes so as to evaluate the outcome

of cancer control initiatives. This would then provide an exemplary model to initiate cancer control programmes in other states in the future. The summary recommendations to plan cancer control activity are tabulated in Table 3.

In India, overall cancer rates are not increasing rapidly but given the increases in colon and breast cancer alongside an ever-increasing number of cancer patients through demographic changes, the burden is set to rise and action on prevention, early detection and treatment is a major public health priority. Further studies are required to identify effects of birth cohort and calendar period on trends in cancer in India so as to undertake informed and evidence-based policy decision on steps for cancer prevention and cancer control.

Conflict of interest

None declared.

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