Cancer Epidemiology 58 (2019) 111–120

Contents lists available at ScienceDirect

Cancer Epidemiology

journal homepage: www.elsevier.com/locate/canep

Transition of cancer in populations in India

Aleyamma Mathew[a,*], Preethi Sara George[a], Jagathnath Krishna K M[a], Durga Vasudevan[a], Francis V. James[b]

[a] Divisions of Cancer Epidemiology & Biostatistics, Regional Cancer Centre, Thiruvananthapuram, Kerala, India
[b] Radiation Oncology, Regional Cancer Centre, Thiruvananthapuram, Kerala, India

ARTICLE INFO

Keywords:
Age-specific cancer incidence rates
Age-standardized cancer incidence rates
Demographic transition
Epidemiologic transition
Overweight and obesity transition
Tobacco-related cancers
Alcohol-related cancers

ABSTRACT

Background & objectives: An assessment of transition of cancer in India during the past 30 years, according to changes in demographic and epidemiologic risk factors was undertaken.
Materials & methods: Cancer registry data (http://www.ncdirindia.org), (population coverage < 10%), was compared with transition in life-expectancy and prevalence on smoking, alcohol and obesity. We fitted linear regression to the natural logarithm of the estimated incidence rates of various cancer registries in India.
Results: Burden of cancer in India increased from 0.6 million in 1991 to 1.4 million in 2015. Among males, common cancers are lung (12.0%), mouth (11.4%), prostate (7.0%), and tongue (7.0%) and among females, they are breast (21.0%), cervix-uteri (12.1%), ovary (6.9%), and lung (4.9%) in 2012. Increased life-expectancy and population growth as well as increased use of alcohol and increased prevalence of overweight/obesity reflected an increase in all cancers in both genders except a reduction in infection-related cancers such as cervix-uteri and tobacco-related cancers such as pharynx (excludes nasopharynx) and oesophagus.
Interpretation & conclusion: Transition in demographics and epidemiologic risk factors, reflected an increase in all cancers in both genders except a reduction in a few cancers. The increasing incidence of cancer and its associated factors demands a planned approach to reduce its burden. The burden assessment needs to be strengthened by increasing the population coverage of cancer registries. Continued effort for tobacco prevention and public health efforts for reducing obesity and alcohol consumption are needed to reduce the cancer burden.

1. Introduction

Cancer incidence rates in India, still lower compared to many western countries [1] have been changing over the recent decades. Transition in the economic status and life-style modification happened in many countries reflected a drastic increase in cancer burden and that are associated with demographic changes and epidemiologic factors such as alcohol, obesity and physical inactivity [2]. Transition of cancer in India resulted, an increase in the burden of the disease, contributing the third highest number of cases globally after China and USA.

In each year, the number of new cancer cases is rising largely in India, mainly due to the demographic changes such as increased population growth and ageing. Further, India has emerged as a fast growing economy and thus occurred changes in the life-styles, including alcohol use, consumption of highly calorific food, increased obesity and a reduction in physical activity. From the 27 cancer registries in India, a total of nearly 1.4 million cancer cases were estimated for the year 2015 (males: 692,704; females: 695,693) and it is predicted that, without any control measures, this figure would increase to 1.74 million cases (males: 871,756; females: 863,130) for the year 2020 [3].

Cancer registry reports in India indicated that there are distinct patterns in the types of cancer at a regional level, mainly due to the heterogeneity in underlying risk factors. Nationally, the five common cancers in men were lung, oral cavity, stomach, colo-rectum, and pharynx (excluding nasopharynx) and in women, breast, cervix uteri, colo-rectum, ovary and oral-cavity [4] and estimated the burden of some of these cancers for the year 2015 (oral cavity: 149,978; female breast: 134,214; lung: 106,794; cervix-uteri: 97,909; colo-rectum: 73,725 and stomach: 44,998) [3].

Several cancers are showing increasing trend and some are declining regionally [3]. Other than the demographic transition, epidemiologic transition in the prevalence of risk factors might have attributed to the transition of cancer in populations. Further, changes in the detection practices, cancer screening and better access to care might have resulted, increased burden of many cancers now. This paper

* Corresponding author at: Division of Cancer Epidemiology & Bio-Statistics, Regional cancer Centre, Trivandrum 695 011, Kerala, India.
E-mail address: aleyammamathewrcc@gmail.com (A. Mathew).

https://doi.org/10.1016/j.canep.2018.12.003
Received 12 June 2018; Received in revised form 29 November 2018; Accepted 3 December 2018
Available online 08 December 2018
1877-7821/

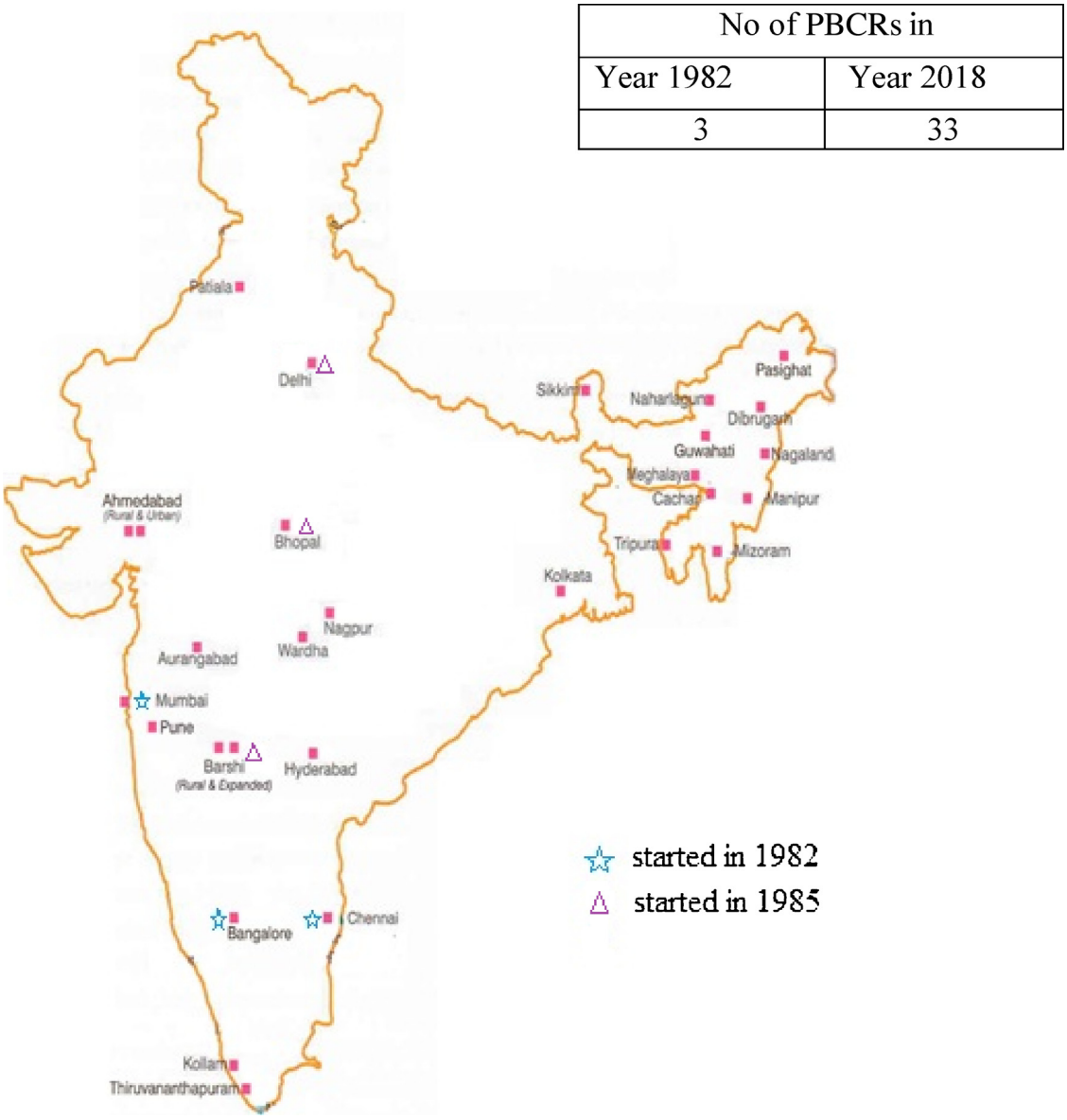

Fig. 1. Transition of Population Based Cancer Registries in India: 2014.

assesses the transition of cancer in India according to the changes in the demographic and epidemiologic risk factors occurred during the past 30 years.

2. Materials and methods

India has one of the oldest cancer registries in the world dating back to 1964 when the Indian Cancer Society established one at Mumbai. The Indian Council of Medical Research (ICMR), initiated a network of three population-based cancer registries (PBCRs) through the National Cancer Registry Programme (NCRP) of Govt. of India, in 1982 at Mumbai, Bangalore and Chennai. In 1985, three more PBCRs at Delhi, Bhopal and Barshi (rural population-based) were established (Fig. 1). Currently there are 27 PBCRs under the NCRP with coverage of less than 10% of the 1.27 billion populations in India [3,5].

In India, for cancer case-ascertainment, 'active-system' is being followed since there is no legislation in the country concerning registration and notification of cancer either at the national or state-level (except administrative orders in some areas). The data collection in each of the PBCRs in India is being carried out by visiting the hospital/nursing homes/laboratories/specialists to enumerate the cancer cases. Medical records and other source documents are abstracted and coded for the registry database. Even though duplicate registrations are to be excluded, the uses of multiple sources for data collection is to prevent cases being missed and ensure that only a few cases may escape from the registry. Information on deaths is also being collected from the departments of vital statistics of the respective cities for adding DCO (death certificates only) cases to the incident database to have complete information on number of cancer cases (Fig. 2).

Data sources for cancer rates were national cancer registry reports (http://www.ncdirindia.org) [6–8]; estimates of cancer incidence in 1991 [9] and estimates of cancer incidence in 2012 [4]. Data sources for life-expectancy, tobacco prevalence, per-capita consumption of alcohol, and prevalence in overweight and obesity were from world health organization, global health observatory data (http://www.who.int/gho/en) [10] and for Gross Domestic Product (GDP) were from world bank (https://data.worldbank.org/country/india) [11].

The various measures used are age-standardised (world population) incidence rate, to compare the rates with various countries (ASR) and annual percent change (APC), to assess the transition in rates. Data on a long time period are available only from registries such as Bangalore, Barshi, Bhopal, Chennai, Delhi and Mumbai. We fitted linear regression

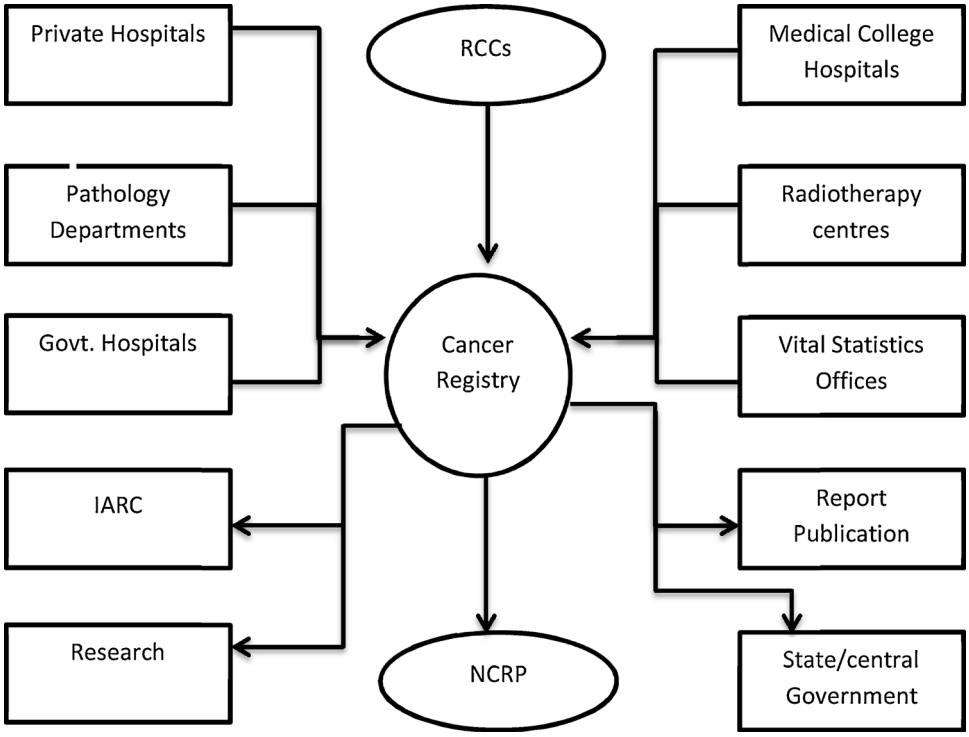

Fig. 2. Active case ascertainment methods in a cancer registry in India.
NCRP: National Cancer Registry Programme of Govt. of India.
IARC: International Agency for Research on Cancer.
RCCs: Regional Cancer Centres.

to the natural logarithm of the estimated rates APC on incidence rates of these registries. JoinPoint linear regression was used to determine trends in cancer incidence (APC), a statistical algorithm detects Joinpoints, or points in time where the slope of the regression line significantly changes. Thus, the model described trends during different time segments. At each segment, trends in rates were measured using the estimated APC, which assumes that rates changes by a constant percentage each year. The JoinPoint regression software was used for the trend analysis [12].

3. Results

Proportion of population growth was 42% and 44% (Fig. 3a & d); increased life-expectancy was 10 years and 11 years (Fig. 3b & e), however, increase in cancer burden was 93% and 64% (Fig. 3c & f) in 2012 compared to 1991 among males and females respectively. Among males, lung is the leading cancer sites in most of the cancer registries in India except in the central region. Mouth is another leading site in the southern, central and western regions in India. In the north-eastern region, among males, stomach is the leading site in many of the registries along with lung and oesophagus where as in Nagaland, nasopharynx holds the position of top leading site (Table 1). Among females, breast is the leading cancer site in the southern, western, and northern registries in India whereas in some of the central and north-eastern registries, cervix-uteri is the leading cancer site. Among the north-eastern registries, oesophagus and stomach are respectively the leading cancer sites in Meghalaya and Naharlagun (Table 2).

The pooled data indicated that lung is the leading cancer site even after 20 years, among males in India. Pharynx (excludes nasopharynx) and oesophagus, which were among the top five leading sites in 1991 found their ranking to be lowered in 2012. Colo-rectum, prostate and stomach were the other emerging cancer sites in males in 2012 (Fig. 4). The pooled data among females indicated that cervix-uteri and breast which were the top leading sites in 1990 interchanged their ranking positions in 2012. Colo-rectum and corpus-uteri, which were not predominant sites earlier, emerged as leading cancer sites in 2012. Ovary maintains its position in the top five leading cancer sites, even though its ranking has declined. Mouth which had fifth position earlier had come down to the tenth position (Fig. 5).

Tobacco prevalence has declined in India in both genders (Fig. 6a & b). Parallel to this, a decline in other pharyngeal and oesophageal cancers was observed in the oldest registries such as Mumbai, Chennai, Bangalore and Delhi. However, increase in lung cancer incidence was observed in both genders (Fig. 6c & d). Among females, statistically significant APCs were 3.9% [95% CI: 2.9–5.4], 4.6% [95% CI: 2.1–5.8], 2.8% [95% CI: 1.5–3.1], and 1.3% [95% CI: 1.1–2.1], in Bangalore, Chennai, Delhi and Mumbai respectively. Also, increase in tongue and mouth cancer incidence was observed in these registries (Fig. 6e & f).

Parallel to the increased aging population (Fig. 3b), prostate cancer rates showed increasing trend in all the older registries except Bhopal (Fig. 7b). Statistically significant APCs were 2.8% [95% CI: 1.9–3.5], 4.1% [95% CI: 3.1–5.2], 3.4% [95% CI: 2.8–4.9], and 1.2% [95% CI: 1.0–2.2], in Bangalore, Chennai, Delhi and Mumbai respectively. Transition in the economic status (Fig. 9a) resulted decline in infection-related cancers mainly cervix-uteri (Fig. 9b). Statistically significant APCs were −2.3% [95% CI: −3.1 to −1.5], −2.2% [95% CI: −2.9 to −0.9], −1.8% [95% CI: −1.1 to −2.8], −3.5%[95% CI: −1.9 to −6.5], −2.7% [95% CI: −2.0 to −5.9], and −2.0% [95% CI: −1.0 to −4.6], in Bangalore, Barshi, Bhopal, Chennai, Delhi and Mumbai respectively.

Life-style modification resulted increasing trend for breast cancers in all the six older registries (Fig. 7a). APCs were 2·8% [95% CI: 1.1–3.2], 1.9% [95% CI: 0.8–2.5], 2.0% [95% CI: 1.7–4.1], 2.5% [95% CI: 2.2–2.9], 1.5% [95% CI: 0.6–2.4], and 1.4% [95% CI: 0.9–2.3] in Bangalore, Barshi, Bhopal, Chennai, Delhi and Mumbai respectively. Increased prevalence in over-weight/obesity in both genders was observed (data not shown among males) (Fig. 8b). Parallel to this, corpus-uteri and ovarian cancers showed increased trend in all the older

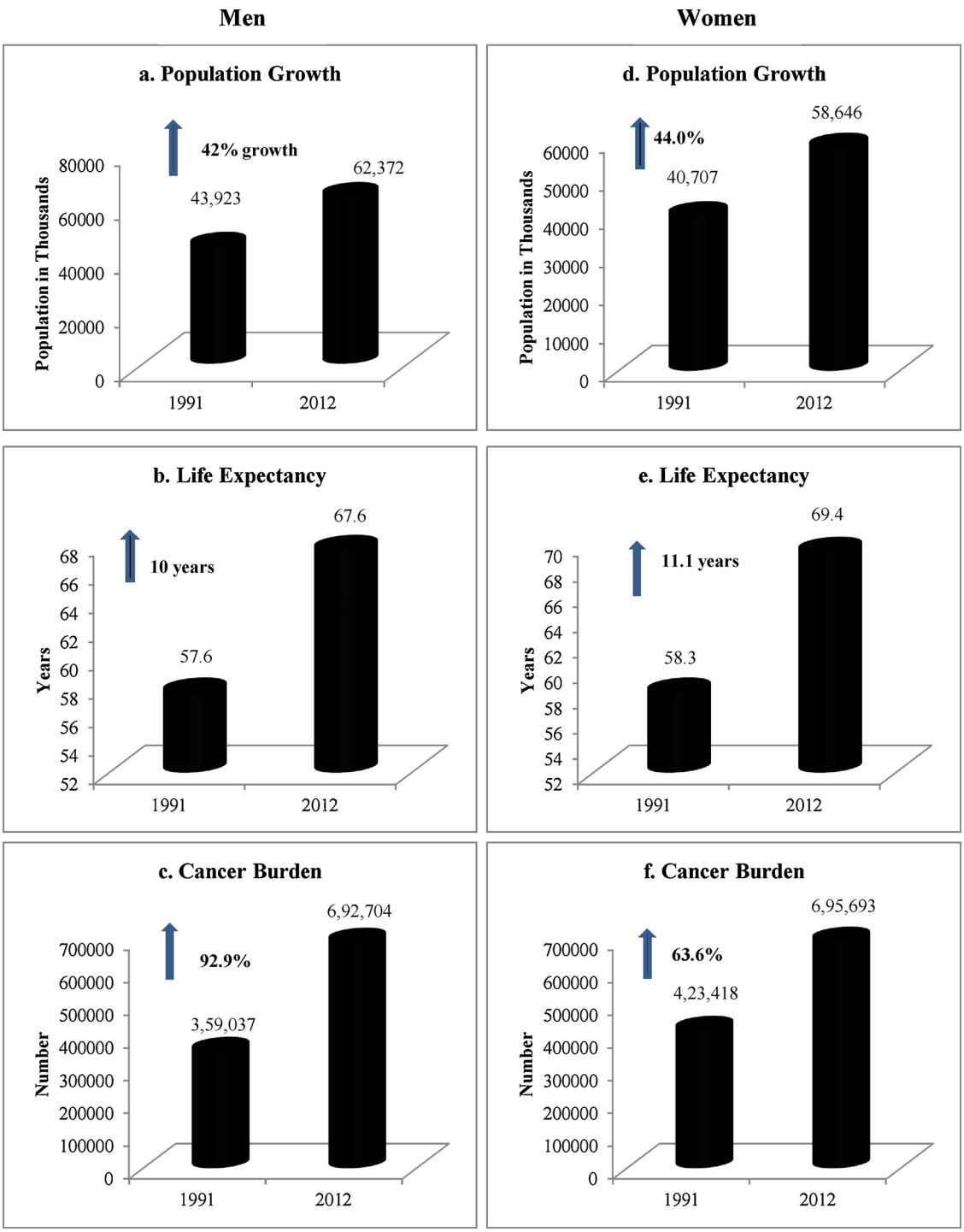

Fig. 3. Demographic Transition vs. Transition of Cancer Burden in Men vs. Women.
Sources: WHO Global health observatory (GHO) data [10] (Fig. 3a–b, d–e); Estimate of cancer incidence in India in 1991 [9]; NCRP Report 2012–14 [3] (Fig. 3c, f)

registries (Fig. 7e & f). Statistically significant APCs for corpus-uteri cancer were 5.5% [95% CI: 2.7–7.2], 3.8% [95% CI: 1.6–5.8.], 3.6% [95% CI: 2.0–4.1], and 2.7% [95% CI: 1.9–3.6], in Bangalore, Chennai, Delhi, and Mumbai respectively. APCs were 2.0% [95% CI: 1.2–3.3], 2.4% [95% CI: 1.6–3.7], 1.6% [95% CI: 1.0–3.3], 1.0% [95% CI: 0.7–1.9], and 0.9% [95% CI: 0.4–1.1], for ovarian cancers in Bangalore, Bhopal, Chennai, Delhi and Mumbai respectively.

Increased prevalence in alcohol consumption among males was observed (Fig. 8a). Some of the related cancers such as colo-rectal cancers showed increased prevalence in some older registries (Fig. 7c & d). Among males, statistically significant APCs for colon cancer were 2.5% [95% CI: 1.4–5.1], 4.0% [95% CI: 3.1–6.3], 2.1% [95% CI: 1.8–3.0], and 1.0% [95% CI: 0.5–1.4], in Bangalore, Chennai, Delhi and Mumbai respectively and for rectal cancers significant APCs were 1.9% [95% CI: 0.8–2.5], 2.6% [95% CI: 1.3–3.6], and 1.3% [95% CI: 0.6–2.2], in Bangalore, Chennai and Delhi were respectively.

4. Discussion

In the present analysis, it was observed that the estimated burden of cancer is huge and it has been increasing with a very high proportion (93.0%) among men in India. Even though cancer registration has a

Table 1
Leading cancer sites in various cancer registries in India (2012–2014): Males.

	Leading cancer sites					%
South						
Bangalore	Lung	Stomach	Prostate	Oesophagus	Brain	36.2
Chennai	Lung	Stomach	Mouth	Tongue	Prostate	39.5
Kollam	Lung	Mouth	Prostate	Liver	Stomach	38.4
Trivandrum	Lung	Prostate	Mouth	Tongue	Rectum	34.6
West						
Ahmedabad	Mouth	Tongue	Lung	Oesophagus	Prostate	49.5
Aurangabad	Lung	Mouth	Tongue	Oesophagus	Larynx	47.1
Mumbai	Lung	Mouth	Prostate	Liver	Tongue	37.7
Pune	Mouth	Lung	Prostate	Tongue	NHL	36.6
North						
Delhi	Lung	Mouth	Prostate	Tongue	Larynx	36.3
Patiala	Oesophagus	Lung	Prostate	Tongue	Mouth	34.3
Central						
Barshi Rural	Mouth	Oesophagus	Liver	Rectum	Tongue	31.3
Bhopal	Mouth	Lung	Tongue	Larynx	Prostate	46.3
Nagpur	Mouth	Tongue	Oesophagus	Lung	Larynx	43.5
Wardha	Mouth	Oesophagus	Lung	Liver	Tongue	39.4
North East						
Cachar	Oesophagus	Hypopharynx	Lung	Mouth	Larynx	38.3
Dibrugarh	Oesophagus	Hypopharynx	Stomach	Mouth	Lung	46.7
Kamrup	Oesophagus	Hypopharynx	Lung	Stomach	Mouth	43.5
Kolkata	Lung	Prostate	Mouth	Tongue	Larynx	44.9
Manipur	Lung	Stomach	Nasopharynx	Oesophagus	NHL	40.1
Meghalaya	Oesophagus	Hypopharynx	Stomach	Lung	Tongue	58.7
Mizoram	Stomach	Oesophagus	Lung	Liver	Hypopharynx	59.3
Nagaland	Nasopharyx	Stomach	Oesophagus	Lung	Hypopharynx	50
Naharlagun	Stomach	Liver	Oesophagus	Lung	Nasopharynx	63.4
Pasighat	Stomach	Liver	Hypopharynx	Oesophagus	Rectum	43.3
Sikkim	Stomach	Liver	Lung	Oesophagus	Nasopharynx	42.8
Tripura	Lung	Oesophagus	Larynx	Stomach	Mouth	44.2

Table 2
Leading cancer sites in various cancer registries in India (2012–2014): Females.

	Leading cancer sites					%
South						
Bangalore	Breast	Cervix uteri	Ovary	Thyroid	Mouth	53
Chennai	Breast	Cervix uteri	Ovary	Corpus uteri	Stomach	58.6
Kollam	Breast	Thyroid	Cervix uteri	Ovary	Mouth	54.9
Trivandrum	Breast	Thyroid	Cervix uteri	Ovary	Corpus uteri	55.1
West						
Ahmedabad	Breast	Cervix uteri	Ovary	Mouth	Tongue	55.5
Aurangabad	Breast	Cervix uteri	Ovary	Lung	Oesophagus	64.4
Mumbai	Breast	Cervix uteri	Ovary	Lung	Gall bladder	51.9
Pune	Breast	Cervix uteri	Ovary	Mouth	Lung	58.1
North						
Delhi	Breast	Cervix uteri	Gall bladder	Ovary	Corpus uteri	58.0
Patiala	Breast	Cervix uteri	Oesophagus	Ovary	Gall bladder	54.4
Central						
Barshi Expanded	Cervix uteri	Breast	Ovary	Tongue	Stomach	60.5
Barshi Rural	Cervix uteri	Breast	Ovary	Oesophagus	Lung	58.7
Bhopal	Breast	Cervix uteri	Ovary	Gall bladder	Mouth	62.2
Nagpur	Breast	Cervix uteri	Ovary	Mouth	Oesophagus	60.9
Wardha	Breast	Cervix uteri	Ovary	Mouth	Oesophagus	58.1
North East						
Cachar	Breast	Cervix uteri	Gall bladder	Oesophagus	Ovary	50.4
Dibrugarh	Breast	Gall bladder	Oesophagus	Ovary	Cervix uteri	54.4
Kamrup Urban	Breast	Oesophagus	Gall bladder	Cervix uteri	Ovary	51.1
Kolkata	Breast	Cervix uteri	Ovary	Gall bladder	Lung	57·8
Manipur	Breast	Lung	Cervix uteri	Thyroid	Ovary	52.1
Meghalaya	Oesophagus	Cervix uteri	Breast	Mouth	Stomach	56.3
Mizoram	Cervix uteri	Lung	Breast	Stomach	Oesophagus	60.0
Nagaland	Cervix uteri	Breast	Stomach	Nasopharynx	Thyroid	56.4
Naharlagun	Stomach	Cervix uteri	Breast	Thyroid	Liver	53.5
Pasighat	Cervix uteri	Breast	Stomach	Ovary	Liver	63.6
Sikkim	Breast	Cervix uteri	Lung	Gall bladder	Stomach	41.7
Tripura	Cervix uteri	Breast	Gall bladder	Ovary	Oesophagus	51.7

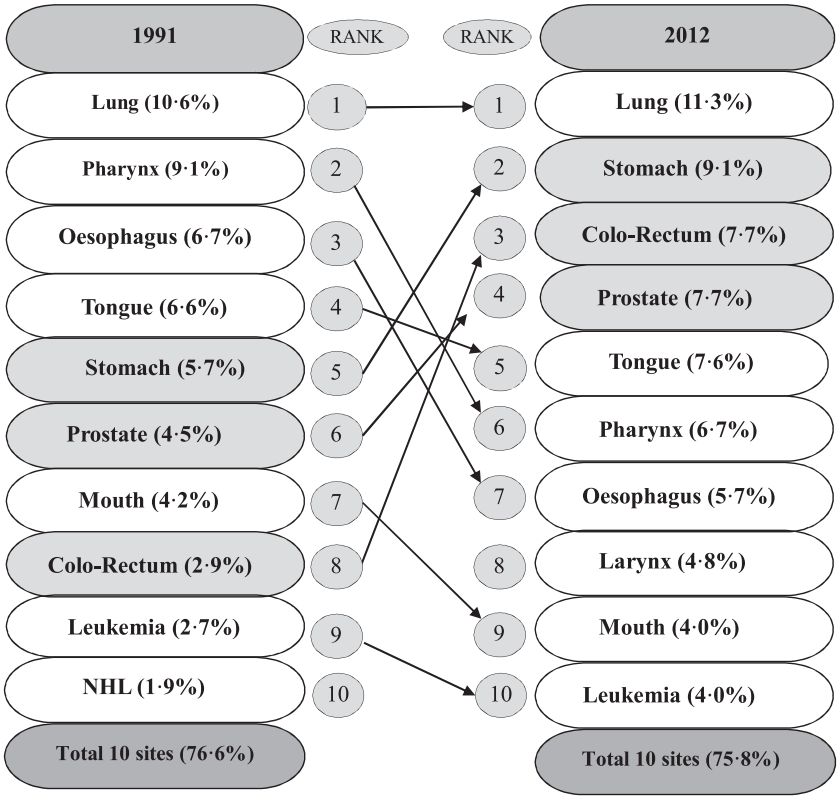

Fig. 4. Transition in rank ordering and proportion of leading cancers: males.
NHL: Non-Hodgkin Lymphoma.
Sources: Estimate of cancer incidence in India in 1991 [9]; GLOBOCAN 2012 [4].

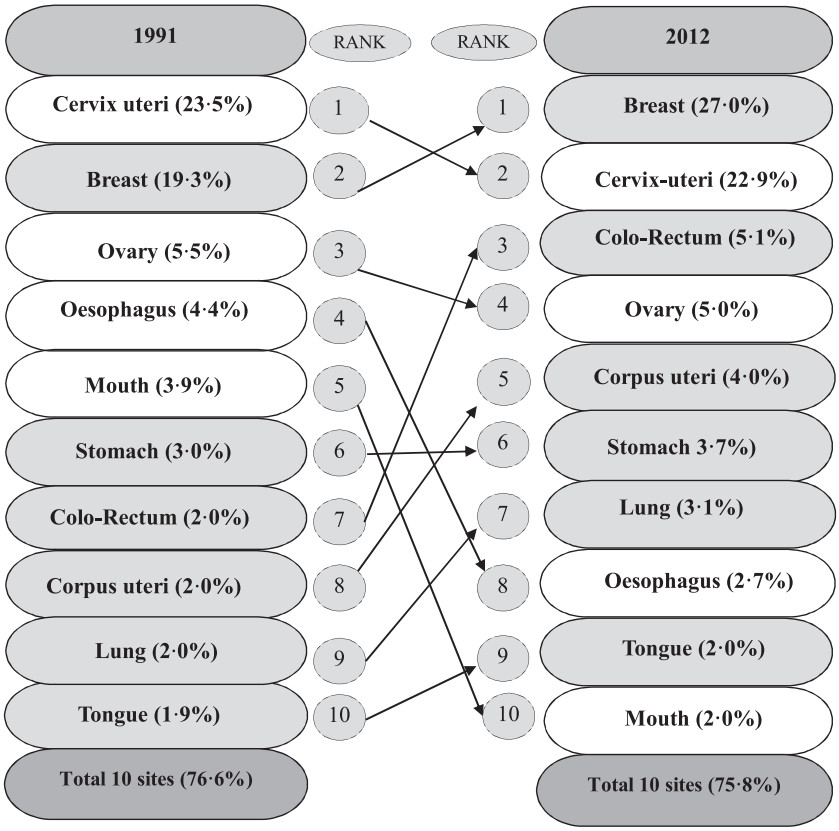

Fig. 5. Transition in rank ordering and proportion of leading cancers: females.
Sources: Estimate of cancer incidence in India in 1991 [9]; GLOBOCAN 2012 [4].

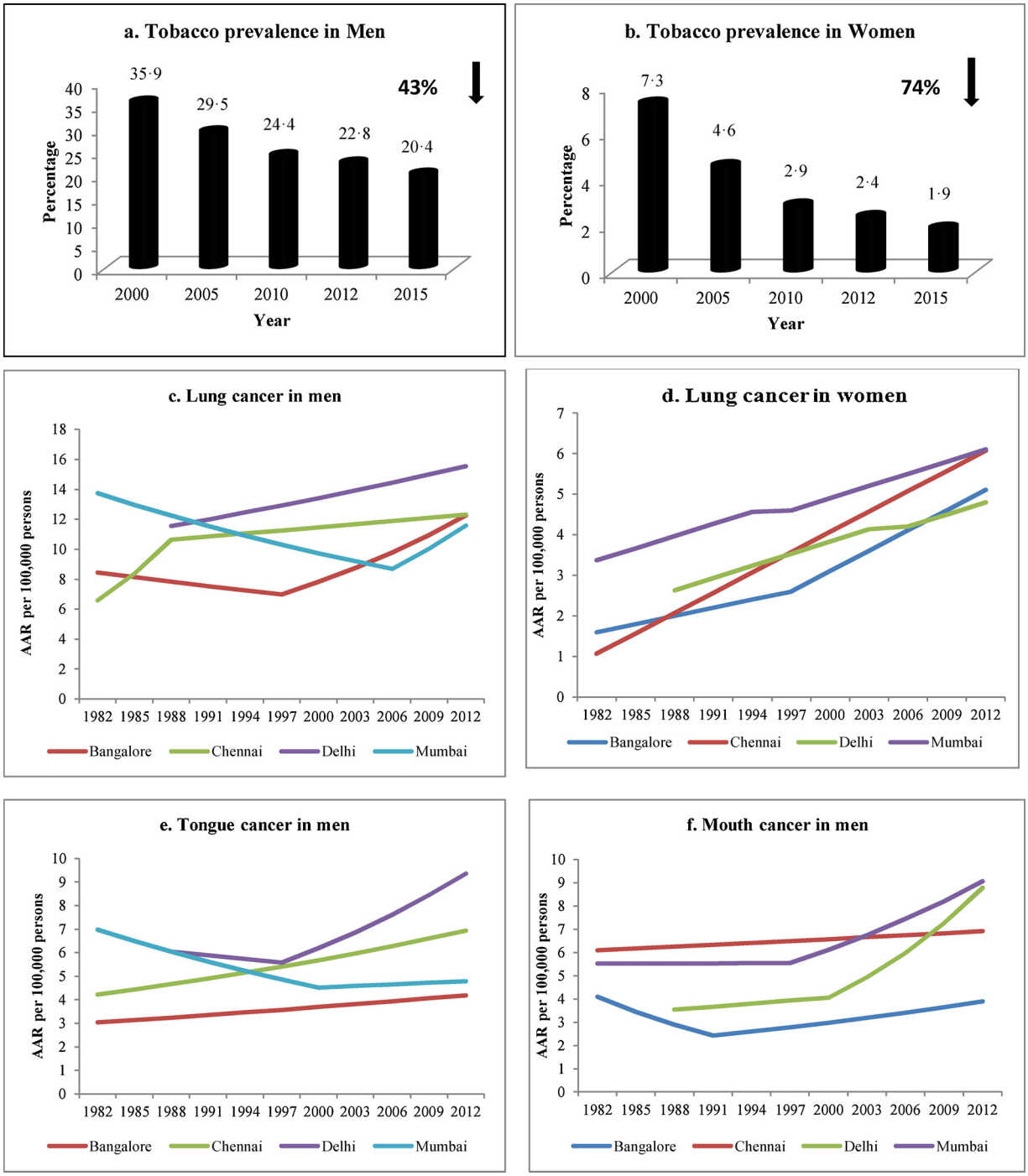

Fig. 6. Transition in Tobacco prevalence vs. Lung, Mouth and Tongue cancers in India.
Sources: NCRP Reports 2006–08 [8], 2009–11 [7], 2012–14 [3], NCRP time Trends 1982–2010 [6].

long history in India, long-time data has been available only for a few registries and thus the transition of cancer pattern could be made only in a few regions, and the population coverage of all cancer registries together was < 10% of the total population in India. Hence it is very important that the population coverage of cancer registries needs to be increased.

Changing demographics leading to increased ageing population are likely to result in increased incidence of certain cancers such as prostate, rectum etc. and thus the future burden of cancer in India will expect to be large. The economic burden of cancer care treatment to be the highest compared to all other diseases and if detected in late stages, treatment cost will be generally 1.5–2 times higher than the cost for early-stage cancers.

A decline in tobacco prevalence was reported in the past 20–25 years in both genders in India. Of the several causes investigated for cancer, the use of smoking and smokeless tobacco has shown strong and consistent associations with several cancer sites such as lung, oral cavity, other pharynx (oropharynx & hypopharynx), larynx, oesophagus and urinary bladder in the body [13,14]. However, no decline in the major tobacco associated cancer sites was observed in the present analysis except a slight decline in pharyngeal (excludes nasopharynx) and oesophageal cancers. It is alarming to note the increase in the incidence of lung cancer in both genders.

It has been reported that cancers such as cervix-uteri, Hodgkin's

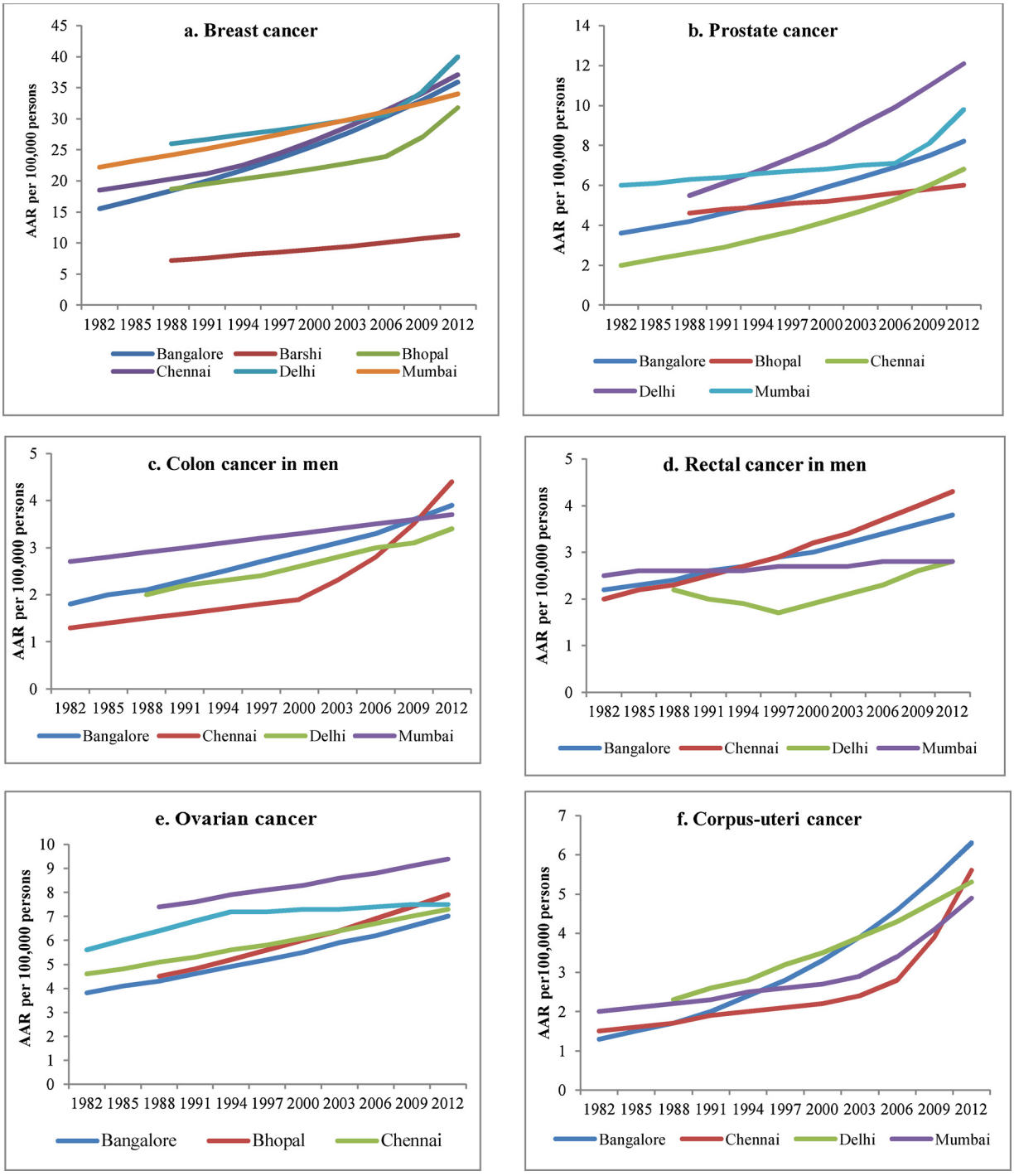

Fig. 7. Transition in Breast, Prostate, Colon, Rectum, Corpus-uteri and Ovarian cancers in India (1982–2014).
Sources: NCRP Reports 2006–08 [8], 2009–11 [7], 2012–14 [3], NCRP time Trends 1982–2010 [6].

disease, nasopharynx, stomach and liver are mainly infection related [15,16]. In India, increase in the economic status and thereby reduction in the poverty clearly indicated reduction in the infection-related cancers such as cervix-uteri. However, life-style modification happened in many parts of the country reflect increased incidence of several related cancers such as breast, colo-rectum, prostate, corpus-uteri etc. What is probably more worrisome is, India witnessing increased incidence of key risk factors such as obesity, physical inactivity, alcohol etc. that contribute to the occurrence of many cancers.

Life-style modification such as delayed child birth and changing breastfeeding pattern are likely to result in increased breast cancer incidence. Excessive use of alcohol is linked to other pharynx, breast, oesophagus (squamous cell carcinomas), liver, colo-rectum [17,18]. Further, changing dietary patterns are linked to the risk in overweight and obesity. It has been reported that increasing overweight/obesity rates and physical inactivity led to an increase in the risk of many cancers such as corpus-uteri, colo-rectum, breast, and oesophagus (adeno carcinomas) [19–21]. Thus increased alcohol consumption, increased prevalence in overweight/obesity and physical inactivity and with the tobacco epidemic, the burden of related cancers in India will be very high. A substantial portion of cancer cases could be prevented by broadly applying effective prevention measures. For instance,

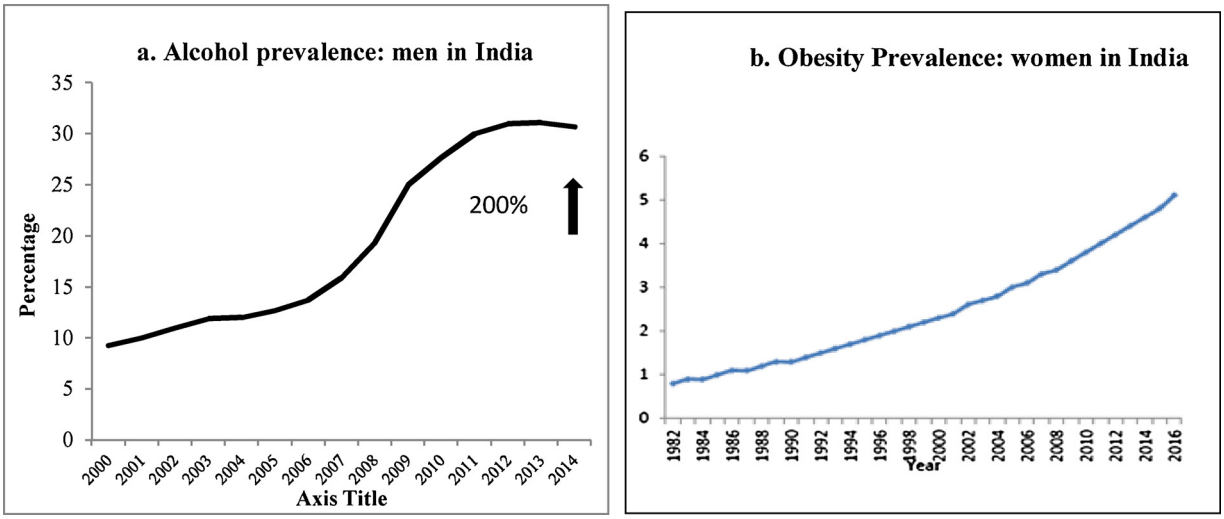

Fig. 8. Transition in Alcohol and obesity prevalence.
Source: WHO Global health observatory (GHO) data [10].

cancers such as breast and cervix-uteri can be cured if detected early and treated adequately.

In the present analysis, an up-down variations was observed in some of the transition graphs (Figs. 6c–d, 7 a–f), which might be due to the variation in the completeness in case-ascertainment existing in cancer registries. Hence, it is very important that cancer incidence data needs to be assessed more accurately.

In conclusion, transition in demographics and epidemiologic risk factors, reflected an increase in all cancers in India, in both genders except a reduction in cancers of the cervix uteri and tobacco-related cancers such as pharynx (excludes nasopharynx) and oesophagus in some geographical areas. The increasing incidence of cancer and its associated factors demands a planned approach to reduce its burden. The burden assessment needs to be strengthened by increasing the population coverage of cancer registries. Continued effort for tobacco prevention and public health efforts for reducing obesity and alcohol consumption are needed to reduce the cancer burden.

Funding

This research did not receive any specific grant from any funding agency in the public, commercial or not-for-profit sector.

Disclosure

The authors have declared no conflicts of interest.

Author contribution

Aleyamma Mathew: Study concept, study design and data collection, literature search, manuscript preparation.

Preethi Sara George: Data analysis and manuscript review and quality control of data.

Jagathnath Krishna K.M.: Quality control of data and manuscript review.

Durga Vasudevan: Data analysis, preparation of figures and tables.

Francis V James: Manuscript review.

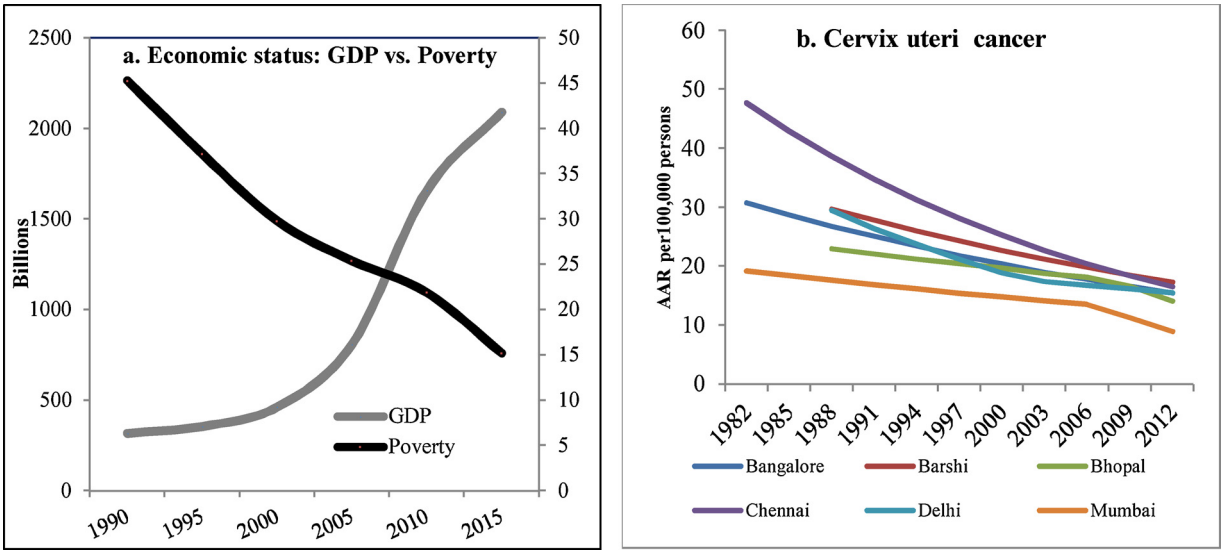

Fig. 9. Transition in Economic status vs. Transition in infection-related cancer in India.
Sources: World Bank [11] (Fig. 9a); NCRP Reports 2006–08 [8], 2009–11 [7], 2012–14 [3], NCRP time Trends 1982–2010 [6] (Fig. 9b).

Acknowledgement

The authors gratefully acknowledge Ms. Anitha V.R., for preparation of graphs.

References

[1] F. Bray, M. Colombet, L. Mery, M. Piñeros, A. Znaor, R. Zanetti, J. Ferlay, Cancer Incidence in Five Continents Vol. XI (electronic version International Agency for Research on Cancer, Lyon, 2017http://ci5.iarc.fr.
[2] A. Mathew, P.S. George, Cancer in populations in transition, 3rd edition, in: P. Boffetta, P. Hainaut (Eds.), Encyclopedia of Cancer, vol. 1, Elsevier, Academic Press, 2019, pp. 191–211, , https://doi.org/10.1016/B978-0-12-801238-3.65156-5 ISBN: 9780128124840.
[3] NCRP – Three-Year Report of Population Based Cancer Registries: 2012–2014, National Cancer Registry Programme (Indian Council of Medical Research), Bengaluru, 2016http://ncdirindia.org.
[4] J. Ferlay, I. Soerjomataram, M. Ervik, et al., GLOBOCAN 2012 v1.0, Cancer Incidence and Mortality Worldwide: IARC Cancer Base No. 11, International Agency for Research on Cancer, Lyon, France, 2013.
[5] Census of India, (2011) http://censusindia.gov.in).
[6] NCRP (National Cancer Registry Programme) – Time Trends in Cancer Incidence Rates: 1982–2010, Indian Council of Medical Research, Bangalore, 2013http://ncdirindia.org).
[7] NCRP (National Cancer Registry Programme)– Three-year Report of Population Based Cancer registries: 2009–2011, National Cancer Registry Programme (Indian Council of Medical Research), Bangalore, 2013http://ncdirindia.org).
[8] NCRP (National Cancer Registry Programme). Three-year Report of Population Based Cancer registries: 2006–2008, National Cancer Registry Programme (Indian Council of Medical Research), Bangalore, 2010http://ncdirindia.org).
[9] D.N. Rao, B. Ganesh, Estimate of cancer incidence in India in 1991, Ind J Cancer 35 (1) (1998) 10–18.
[10] WHO Global health observatory (GHO) data (http://www.who.int/gho/en).
[11] World Bank; https://data.worldbank.org/country/india.
[12] H.J. Kim, M.P. Fay, E.J. Feuer, D.N. Midthune, Permutation tests for joinpoint regression with application to cancer rates, Stat. Med. 19 (2000) 335–351.
[13] International agency for research on cancer (IARC), IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans, Supplement. Overall Evaluations of Carcinogenicity: an Updating of IARC Monographs volumes 1–42, IARC press, Lyon, 1987, pp. 357–361.
[14] US Department of Health and Human Services, The Health Consequences of Smoking: A Report of the Surgeon General, US Department of Health And Human Services, Centres for Disease Control and Prevention, National Centre for Disease Control and Prevention and Health Promotion, Office on Smoking and Health, Atlanta, 2004.
[15] M. Plummer, C. de Martel, J. Vignat, et al., Global burden of cancers attributable to infections in 2012: a synthetic analysis, Lancet Glob. Health 4 (2016) e609–16.
[16] C. deMartel, M. Plummer, J. Vignat, S. Franceschi, Worldwide burden of cancer attributable to HPV by site, country and HPV type, Int. J. Cancer (2017) 664–670.
[17] R. Baan, et al., On behalf of the WHO international agency for research on Cancer monograph working group. Carcinogenicity of alcoholic beverages, Lancet Oncol. 8 (2007) 292–293.
[18] J. Connor, Alcohol consumption as a cause of cancer, Addiction 112 (2) (2017) 222–228.
[19] M. Ezzati, A.D. Lopez, A. Rodgers, et al., Selected major risk factors and global and regional burden of disease, Lancet 360 (2002) 1347–1360.
[20] D. Schmid, M.F. Leitzmann, Association between physical activity and mortality among breast cancer and colorectal cancer survivors: a systematic review and meta-analysis, Ann. Oncol. 25 (7) (2014) 1293–1311.
[21] D.M. Parkin, L. Boyd, L.C. Walker, The fraction of cancer attributable to lifestyle and environmental factors in the UK in 2010, BJC 105 (2011) S77–S81.