RESEARCH COMMUNICATION

Stage at Diagnosis and Relative Differences in Breast and Prostate Cancer Incidence in India: Comparison with the United States

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Abstract

Purpose: To examine and reconcile differences in incidence rates and stage-at-initial-presentation of prostate and breast cancers in India, a country in epidemiologic transition. Methods: Age-adjusted prostate and female breast cancer incidence rates and proportion of cases by stage-at-diagnosis were compared. Data were derived from the National Cancer Registry Program of India, other Indian registries, the International Agency for Research on Cancer, and the US/ NCI Surveillance, Epidemiology, and End Results (SEER) Program. Results: Average annual cancer incidence rates in India ranged from 5.0 to 9.1 per 100,000/year for prostate and 7.2 to 31.3 per 100,000/year for female breast. Comparative rates in the US for prostate cancer are 110.4 for Whites and 180.9 for Blacks; for female breast, the rates are 86.6 for Blacks and 96.4 for Whites. Notable differences were observed between rural and urban areas in India, while such differences by rurality appear to be much smaller in the US. Overall, about 50-55% of breast cancer cases and about 85% of prostate cancers were detected at late (III and IV) stage; in contrast to the US where 15% of either cancer is diagnosed at late stage. Conclusions: Differences in stage-at-diagnosis help explain variations in incidence rates among cancer registries in India and rate differences between India and the US. These findings indicate that erroneous inferences will result from incidence-rate comparisons that do not take into account stage-at-diagnosis. Results also point to epidemiologic studies that could be conducted to deepen understanding of the etiology of these cancers. By enhancing data on staging, the Indian cancer registries could widen the scope of collaborative, cross-national research.

Key Words: Prostate cancer - breast cancer - epidemiology - incidence - India - stage at diagnosis - screening

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Introduction

India, a vast nation with a human population of over one billion, is the largest country on the Indian subcontinent in South Asia and home to about 16% of the world's population (Desai, 2002). India also is home to a variety of unique linguistic, religious, and culinary traditions. Some of these, most notably those related to diet, have been associated with cancer-related outcomes (dos Santos Silva et al., 2004; Gupta et al., 1999; Gupta et al., 1998; Hebert et al., 2002; Krishnaswamy, 1996; Messer, 1997; Sengupta et al, 2000; 2004b; Sinha, Anderson, McDonald, & Greenwald, 2003). Indeed, there is a vast literature on the role of specific components of Indian diet on cancer in laboratory models of carcinogenesis (Manju & Nalini, 2005; Sengupta et al, 2004a). With occasional additions of foods from other cultures, most notably during the 16th and 17th centuries, the essential elements of the Indian traditional diet has been a distinct feature of Indian populations for centuries. These diets, which vary regionally and by socio-religious group, have been characterized by being primarily, and exclusively in many instances, vegetarian (Hebert et al., 1998;1999; 2000). As part of religious 'prescriptions' diet also is part of larger lifestyle patterns that include yoga, massage, sleep hygiene, and rules of ethical behavior (Aruna & Sivaramakrishnan, 1992; Gogtay et al, 2002; Malhotra, 1967; Popkin, 2002; Popkin, Horton, Kim, & Mahal, 2001; Shetty, 2002; Sinha et al., 2003; Storer, 1977). This general pattern of eating (and associated behaviors) is consistent with scientific evidence indicating an association with lower rates of chronic diseases, such as cancer, and is hypothesized to be the explanation for relatively low occurrence of these

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diseases in India (Aruna & Sivaramakrishnan, 1992; Popkin et al., 2001; Sinha et al., 2003). However, limitations in data quality and comparability make it difficult to draw inferences with confidence.

Though traditionally agrarian and rural, with rapid industrialization and urbanization, India is changing from a developing to a developed country. Changes in diet, lifestyle, and physical activity patterns, which constitute the basis of this demographic and epidemiologic transition (Popkin, 2002; Popkin et al., 2001), are being observed along with what appears to be concurrent rapid increase in the rates of chronic diseases such as cancer (Shetty, 2002). Presently, rates of most cancers in India are lower than those in more developed countries such as the United States (Sinha et al., 2003). However, it is projected that the gap will be narrowing over the next decade or so (Pal & Mittal, 2004). As we show, it appears to have begun to do so.

Cancer is responsible for about 20% of all deaths in industrialized countries and 10% of deaths in developing nations (Jones et al., 2006; "Stat bite: Estimated worldwide cancer mortality among men, 2002"; 2005). However, the cancer burden in developing countries, including India, is expected to increase (Boutayeb & Boutayeb, 2005). Information about the frequency and patterns of cancer is an essential prerequisite for understanding the epidemiology of specific cancers. As we have discussed, descriptive epidemiology based on excellent cancer registry data can reveal important discrepancies in evidence from analytic epidemiologic studies that could shed light on the underlying causes of cancer (Hebert, 2005; Hebert et al., 2006b). After all, competent population-based cancer registries do not suffer from selection biases and resultant problems with inference that typically plague epidemiologic studies (Greenland & Robins, 1986; Rothman, 1988). Such information also is crucial for planning cancer control programs. In addition, India is an important country because of its size, strategic importance, and as a model for development as it undergoes a historic demographic and epidemiologic transition (Gopalan, 1999; "Health and Development Initiative India. World Health Day 2002" 2002; Nandakumar et al., 2004).

This paper reviews the recent trends in breast and prostate cancer incidence observed in various regions in India. We chose to focus on these two cancer sites in the context of the demographic and epidemiologic transitions because of their proven historical importance in countries that have undergone these transitions (Haynes, 1986; Kodama et al., 1992; Zheng et al., 2005), their public health relevance globally (Brudnak & Hoener, 2003; Ferlay et al., 2001; , Food, Nutrition and the Prevention of Cancer: A Global Perspective, 1997; Ries et al., 2005; US Cancer Statistics Working Group, 2005), and their putative importance for assessing future trends in cancer risk (Parkin et al., 2001). We present an overview of the trends in these two cancer sites, by geographical region, and registry location (rural versus urban). In this, we emphasize differences observed in stage at initial presentation. Finally, the possible role of screening in order to identify a larger number of cases at an earlier disease stage is explored.

Figure 1. Locations of Cancer Registries in India (Courtesy of Dr A Nandakumar)

Materials and Methods

Indian Cancer Registries:

Cancer registration and data abstraction in India is performed mainly by the cancer registries situated in various regions of India (Figure 1). Many of these cancer registries were established by the Indian Council for Medical Research in 1982 under the National Cancer Registry Programme (Nandakumar et al., 2004). In addition to these, there are some additional registries which are not under the National Cancer Registry Programme, but collect and provide important cancer data. Because they are linked to real, geographically defined, population bases, the population-based cancer registries are able to compute cancer incidence rates. Therefore, we used reports published by all population-based cancer registries in order to obtain age-adjusted incidence rates. On the other hand, the hospital-based registries are constrained to provide just relative incidence. However, they provide valuable information on other aspects such as stage at diagnosis, which we incorporated in this study. Data on stage at initial presentation were obtained from hospital-based cancer registries and from previous publications, as cited.

Method of Reporting and Calculation of Incidence Rates:

Usually cancer incidence rates are reported as the number of newly incident cases arising in the covered population in a given period of time, typically one calendar year. The convention, used here, is to express the rate as number of

incident cases per 100,000 population per year. Often the base population is a geopolitical unit (e.g., a state, one or more districts, or well-defined metropolitan area) and the rate is age-adjusted to a standard population for purposes of comparison. Usually when data are available for more than one calendar year, the average annual rates are reported (Nandakumar et al., 2004).

Because cancer is not a notifiable disease in India, an active method of data collection is used.The registrars receive advance training and administer the workers from the registries who are involved in processes such as scanning hospital records in the base population area, clarifying incomplete or contradictory information, and abstracting data from several different potential data sources (Nandakumar et al., 2004). The data thus obtained through the Indian Cancer Registries, as well as through the published studies conducted in Indian populations, were summarized and compared to discern if there were differences in stage at initial presentation.

Other Sources of Incidence Rate Statistics:

We used International Agency for Research on Cancer (IARC)'s publication, 'Cancer Incidence in Five Continents-Vol. VIII', and USA's Surveillance, Epidemiology, and End Results (SEER) program statistics as other sources of incidence data. These were used to make comparisons between India and the US Incidence rates in all populations described in this study were age-adjusted to the world standard population 2001 (Nandakumar et al., 2004).

Data on Stage at Diagnosis:

Data on stage at diagnosis in India were obtained mainly through hospital-based registries and published studies. These sources use the 'clinical extent of disease' system and classify the information on stage into three categories- 'localized', 'regional' and 'distant'. This differs from the Tumor Node Metastasis (TNM) system, which classifies the cancers into stage I through IV. Hence, we had to make certain assumptions and use references in the literature to present the stage information in TNM style.

Years Covered:

The results presented in this study are based mainly on the statistics for the period 1993-97, and 1997-98, and are specified in the results section. For comparability, we used the IARC and SEER statistics for approximately the same time period.

Methods of Comparison:

Because the focus is on a descriptive comparison of rates across populations, no formal statistical methods of hypothesis testing are presented.

Results

Based on data from the India population-based registries, we observed a steady increase in age-adjusted incidence rates of most cancers over the years covered. The all-sites age-standardized (to world standard population) cancer incidence rates in urban NCRP cancer registries in India for the period 1990-96 ranged from 97.8 to 121.9 per 100,000 for men and from 92.2 to 135.7 per 100,000 for women (Table 1). The Delhi registry recorded the highest incidence for both men and women, whereas the rates from the rural population-based registry in Barshi (in the Western Indian state of Maharashtra) were the lowest, at 46.2 and 57.7 per 100,000 for men and women, respectively (Nandakumar et al., 2004). In comparison, the corresponding rates for the US range from 291.4 to 538.6 per 100,000 for men and from 175.3 to 311.5 per 100,000 for women (SEER all sites rates for 1992-1997 adjusted to world standard population). Since 1985, the cancer registries in India have reported a 12% increase in cancer cases (Pal & Mittal, 2004), which is much higher than the rate of increase in the US. The Indian rates for tobacco-related cancer sites such as oral and esophageal cancer are among the highest in the world, whereas for other sites, such as prostate, they are among the lowest recorded

Table 1. Average Annual Age-adjusted Incidence Rates for all Sites per 100,000 in Indian Population-based Cancer Registries (1997)

Registry	Setting	Years Covered	Males	Females
Bangalore*	Urban	1990-1996	97.8	122.1
Barshi*	Rural	1990-1996	46.2	57.7
Bhopal*	Urban	1990-1996	100.4	92.2
Chennai*	Metropolitan	1990-1996	104.6	115.3
Delhi*	Metropolitan	1990-1996	121.9	135.3
Mumbai*	Metropolitan	1990-1996	115.4	119.1
Ahmedabad	Urban	1993-1997	107.2	82.9
Karunagapalli	Semi-urban	1993-1997	102.6	76.0
Kolkata	Metropolitan	1998-1999	102.1	114.6
Nagpur	Urban	1993-1997	118.4	118.8
Pune	Urban	1993-1997	103.9	115.3
Thiruvananthapuram	Urban	1993-1997	87.8	81.1

* NCRP registries Source: 1.National Cancer Registry Program-First All India Report 2001-2002. 2. Individual reports from non-NCRP registries

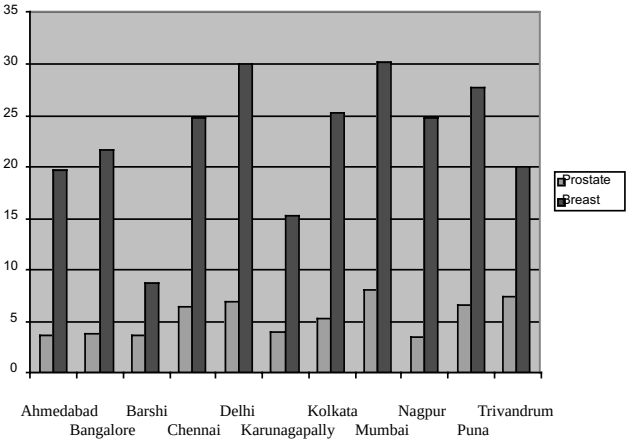

Figure 2. Breast and Prostate Cancer Incidence Rates in India (1997). Source: National Cancer Registry Programme-First All India report 2001-2002

Table 2. Combined Breast Cancer and Prostate Cancer Incidence and Mortality Rates in Indian Population-based Cancer Registries (1990-1998)

Site	Incidence	Mortality	Prevalence	
	Age standardized rates		1-year	5-year
Prostate	4.6	3.0	12,988	42,521
Breast	19.1	10.4	71,493	269,470

Source: National Cancer Registry Programme-First All India Report 2001-2002

(Jones et al., 2006; Sinha et al, 2003; "Stat bite: Estimated worldwide cancer mortality among men, 2002", 2005).

The overall age-standardized incidence rate from all registries was 4.6 per 100,000 for prostate cancer and 19.1 per 100,000 for breast cancer. Again, the range in incidence rates of both these sites (1.5 to 7.1 per 100,000 for prostate, 8.8 to 28.6 per 100,000 for breast) varied by registry regions and a clear difference was observed between the rural registry area (Barshi) and other registries (located in or near urban areas) (Figure 2). Mortality and prevalence rates of the two cancer sites differed noticeably in magnitude as well (Table 2).

A ten-year report (1983-1993) of the hospital-based cancer registries suggests that at the time of diagnosis, the percentage of patients with localized disease for all cancer sites combined was only 24.3 % in men and 22.8 % in women, about the inverse of the situation in the United States in the corresponding period (Parker, Tong, Bolden, & Wingo, 1997) and indicating an overall late detection phenomenon in India.

Trends in Prostate Cancer Incidence:

Prostate cancer is a much more commonly diagnosed disease in the West than in India; it is the most prevalent cancer in American men and those from other Western countries (Drake et al., 2006; Hebert et al., 1998). For example, the age-adjusted incidence in US Black population is more than 18 times higher than that observed in the population in Mumbai, India (Hsing et al., 2000). However,

Table 3. Age-adjusted Incidence Rates of Prostate and Breast Cancer per 100,000 in Indian Population-based Cancer Registries (1997)

Registry	Female Breast	Prostate
Bangalore*	22.1	4.3
Barshi*	8.8	1.5
Bhopal*	19.9	5.1
Chennai*	21.6	3.8
Delhi*	28.1	6.5
Mumbai*	28.6	7.1
Ahmedabad	19.1	3.6
Karunagapalli	15.0	-
Kolkata	25.1	5.3
Nagpur	24.2	-
Pune	26.9	6.6
Thiruvananthapuram	19.7	4.0

* NCRP Registries Source: National Cancer Registry Programme-First All India Report 2001-2002

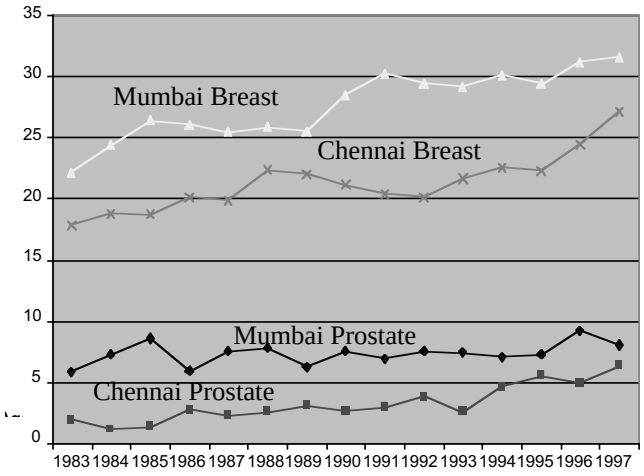

Figure 3. Breast and Prostate Cancer Incidence: Time Trends in Two Urban Registries. Source: National Cancer Registry Program-First All India report 2001-2002

over the last two decades the incidence of prostate cancer in India has been increasing across most registry regions (Banerjee et al., 2003; Ferlay et al., 2004; Nandakumar et al., 2004), as illustrated by the example of Chennai and Mumbai registries (Figure 3). Large differences exist in the age-standardized prostate cancer rates in India. The rural population-based registry at Barshi, in Western Maharashtra, recorded the lowest age-standardized incidence of 1.5 per 100,000; whereas the Mumbai registry had a higher incidence rate of 7.1 per 100,000 (Table 3). A study reported the highest incidence of prostate cancer in the country (11.6 per 100,000) at Jaipur in Rajasthan state (Sharma et al., 1994). The world age-standardized US rates for the same period as reported by SEER registries were 110.4 for Whites and 180.9 for Blacks.

Prostate Cancer Stage at Diagnosis:

As noted, prostate cancer is generally not diagnosed in early stages In India. The proportion of cases classified as 'regional' (which partially represents stage III) and 'distant' (Stage IV) illustrate this fact (Table 4). A study conducted

Table 4. Indian Hospital-Based Registries: Comparison of Stage at Initial Presentation

Registry (years)	Cancer site	Stage distribution (%)			
		Loc	Reg	Dist	Other
Chandigarh (84-89)	Prostate	18.4	58.2	23.4	0.0
	Breast	14.3	71.5	14.3	0.0
Mumbai (84-93)	Prostate	14.1	22.1	58.9	4.9
	Breast	31.9	51.9	12.1	4.1
Bangalore (84-93)	Prostate	20.0	20.0	54.7	5.3
	Breast	16.0	62.0	20.7	1.3
Chennai (84-93)	Prostate	5.6	45.1	49.3	0.0
	Breast	2.6	78.6	18.7	0.1
Thiruvananthapuram	Prostate	41.1	41.1	16.4	1.4
(84-93)	Breast	18.2	71.2	10.0	0.4

Source: National Cancer Registry Programme-Hospital-based registries report

at the Bombay Hospital Institute of Medical Sciences suggests that the proportion of prostate cancer cases diagnosed at an advanced stage may be as high as 84% at initial presentation (Srinivas et al., 1995). This is in stark contrast to the situation in the US, where the converse is true; i.e., only about 15% of patients are diagnosed at an advanced stage (Parker et al., 1997).

Trends in Breast Cancer Incidence:

As for prostate cancer, age-standardized breast cancer incidence in India is significantly lower than in the United States and Europe (Ferlay et al., 2004; Raina et al., 2005). However, most registries indicate an increasing trend over the years. The data from the Chennai and Mumbai registries demonstrates this trend (Figure 3). Breast cancer is now replacing cervical cancer as the leading cancer site in most registries, especially in urban areas (Nandakumar et al., 2004), although the trend can be seen even in predominantly rural areas such as Eastern Rajasthan (Sharma et al., 1994). It is emerging as the leading cause of cancer mortality in Indian women. Nearly 80,000 new cases of breast cancer are diagnosed annually in India (Sinha et al., 2003). This number is projected to surpass 100,000 by the year 2010 (Saxena et al., 2002).

Age-standardized female breast cancer rates in India evince about four-fold range in the population-based cancer registries. Again, a notable difference is observed between the rural and urban areas (Table 3). The rural registry at Barshi registered the lowest incidence rate of 8.8 per 100,000; the semi urban registry at Karunagapalli in Southern India had an intermediate rate of 15.3 while the registries in urban regions such as Delhi and Mumbai had higher incidence rates of around 28 per 100,000 (Nandakumar et al., 2004). The Kolkata Registry in the Eastern region showed an incidence rate of 25.1 (Chopra, 2001; Sen & Sankaranarayanan, 2002). By comparison, the US rates were 86.6 and 96.4 per 100,000 for Blacks and Whites, respectively.

Reflecting an interesting trend, age-specific female breast cancer incidence rates from most of the urban registries show a steep increase until about the time of menopause (age 49 years), and then the rates plateau. This is very dissimilar to the general pattern observed in Western women, in whom breast cancer rates increase sharply after menopause. Recent trends, especially among urban Indian women, indicate that the increase in incidence is higher post-menopausally (Nandakumar et al., 2004; Yeole & Kurkure, 2003). This observation also alludes to the other possible factors responsible for a relatively greater incidence of breast cancer in India (compared to prostate cancer), beyond the difference explained by late stage at diagnosis.

Breast Cancer Stage at Diagnosis:

Breast cancer constitutes nearly one fifth of all female cancers in India, and many patients present with advanced disease. On average, 57% of breast cancer cases in India present at late stage (stage III and IV) (Chopra, 2001), and in some areas as many as 70% of breast cancer cases are locally advanced when diagnosed (Table 4) (Singletary & Connolly, 2006). Although much higher than the 12% figure observed in the US (Goel et al., 1995), this is still much lower than the 85% observed for prostate cancer.

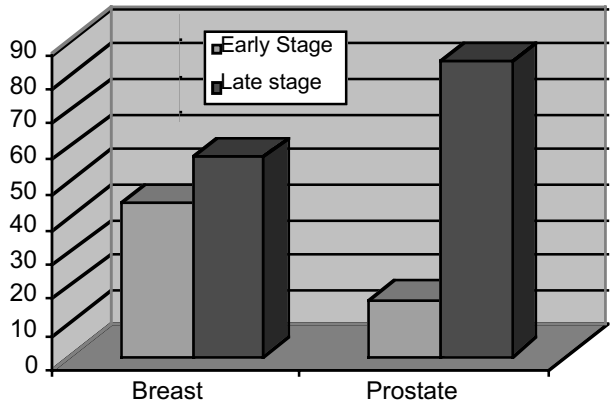

Figure 4. Proportion (%) of Cancer Cases by Stage at Initial Presentation in India. Sources:1. National Cancer Registry Program-First All India report 2001-2002 2. Srinivas et al.,1995

Comparing Breast and Prostate Cancers

For both of these cancers, the age-adjusted incidence rates in India were much lower than those reported by SEER in the US for approximately the same period (1992-1997). The difference was much more striking for prostate (up to 18-fold) than breast (3- to 4-fold) (Ries et al., 2005). However, it should be kept in mind that in the US, both of these cancers are subject to extensive population-based and diagnostic screening as compared to India.

For both breast and prostate cancers noticeable differences could be observed by rurality (i.e., rural versus urban), hospital-based versus population-based registry, and by geographic region. For example, data from the population-based registry in Mumbai indicate that 55% of incident prostate cancer cases were in men > 70 years of age, whereas for the Mumbai hospital-based registry, the proportion in that age group was 33%. The proportion of late-stage prostate cancer cases was very different as well; i.e., 62% for population-based registries and 32% for hospital-based registries. In general though, the proportion of late-stage breast cancer cases was much lower than the proportion of late-stage prostate cancer cases (Figure 4).

Discussion

Reports from Indian cancer registries and epidemiologic studies on cancer incidence in India reveal intriguing trends in both breast and prostate cancers. Across regions, either within India or comparing India to the US, there appears to be a generally inverse relationship between recorded incidence of each cancer and virulence (as measured by stage). This suggests that potentially treatable, early-stage disease is going undetected until very late in the natural

history of the cancer.

These findings also point to interesting areas on which to focus future research. Potential studies range from those focused on cancer etiology to ones focusing on provision of health services. Based primarily on ecological and laboratory evidence, the traditional Indian diet, though varying regionally and across socio-religious groups, would be expected to be associated with low rates of non-tobacco-related epithelial cancers (Branca & Lorenzetti, 2005; , Food, Nutrition and the Prevention of Cancer: A Global Perspective, 1997; Hebert, 2004; Hebert et al., 1998; Hebert & Rosen, 1996; Sinha et al., 2003). India is in demographic transition, a process which began over 50 years ago and has been uneven across the population (Dasgupta, 1995; Purohit, 2004) evincing a pattern typical of much of the current developing world (Bardhan, 2006; Wade, 2004). Recent changes in the economic status of many Indians, including a burgeoning middle class and a general pattern of urbanization (Misra et al., 2001; Purohit, 2004; Tiwari, Kumar, & Kumar, 2005; Wade, 2004), has in fact accelerated the epidemiologic transition (Chopra, 2001; Pal & Mittal, 2004).

India provides an extraordinarily interesting venue for examining the effect of lifestyle, most notably diet, and changes in those factors on both cancer rates and changes in rates. This is because dietary behavior and adherence to dietary traditions are not entirely under the dominance of economic influences (as they had been in Western cultures); in India these behaviors are largely determined by socio-religious factors (Chadha, 1995; Sinha et al., 2003). Therefore, the kinds of potential for confounding of the diet-cancer relationship that might exist in other cultures probably would be substantially reduced in India. This creates interesting opportunities to investigate the role of diet and other risk factors, such as physical activity, that we would expect to co-vary in unusual and potentially illuminating ways.

The issue of variability of cancer rates in India, especially when contrasting the urban and rural registries, is fascinating. This urban-rural contrast, which appears to be proportionally as large as US-India difference in some instances, may hold the key to understanding the relationship between low incidence and late stage of these cancers. Additionally, it possibly throws light on the trends observed in transitioning nations such as India. The importance of the urban-rural contrast is illustrated by the fact that that in the US, SEER rates (which represent virtually no African Americans living in rural areas) are often different from those derived from the National Program of Cancer Registries data (which does represent the 55% of African Americans who live in the rural Southeast) (Hebert, 2003; Hebert, 2005; Hebert et al., 2006a; 2006b; Ries et al., 2005; US Cancer Statistics Working Group, 2005). For example, prostate cancer incidence rates among African Americans in the South Atlantic region are generally about 10-15% higher than they are nationally (US Cancer Statistics Working Group, 2005; Drake et al., 2006). This raises interesting questions about the possible role of genetic factors related to admixture (Parra et al., 2001) that may relevant to the situation in India (and other parts of the world).

Using registry-derived data of uniformly very high quality we are able to comment on racial differences in cancer rates in very much smaller geopolitical units; e.g., the State of South Carolina (Hebert et al., 2006a; South Carolina Cancer Alliance, 2005). The results from our exploration are intriguing and point to the need for both improved and expanded data collection methods and research to understand the causes for the observed trends, both real and artifactual. Indeed, it is important to note that the trends should be interpreted with caution for several reasons. The establishment of cancer registries and collection of cancer data in India is a relatively recent phenomenon and the facilities are still in the developing stages. Additionally, the existing registries cover limited geographical regions. Consequently, large areas of the population, particularly the rural areas, are still not covered sufficiently and the patterns of cancer in these areas remain largely unknown.

This work underlines the need for improvements in standardizing collection techniques across areas and understanding, within the constraints of the data, how differences in access to care, knowledge, attitudes, and beliefs can lead to differences in the overall detection rate of disease. It also may point to an explanation for the observed differences in incidence and virulence between what are generally more occult prostate cancers and more palpable breast cancers.

Clearly, the use of registry data in the United States; where we are able to categorize according to histologic and anatomic subtype, stage, and grade of disease, has allowed us to make significant progress in understanding racial differences in the descriptive epidemiologies of several cancers, most notably squamous cell carcinomas of the esophagus (Hebert et al., 2006b). Data on staging reported by most cancer registries in India are not presented according to the staging systems more commonly used clinically, such as the American Joint Committee on Cancer (AJCC)/UICC Tumor Node Metastases (TNM) stage grouping. Instead 'clinical extent of disease' classified as 'localized', 'regional', and distant is reported. References suggest that these represent 'stage 0 and I', 'stage II and III', and 'stage IV' of the TNM system, respectively (Reynolds, 2002; Singletary & Connolly, 2006). But even this information is often incomplete, and many cases are classified as 'stage unknown'. This leads to an approach of making reasonable assumptions and then drawing inferences. However this in turn limits direct comparisons with data from the West. We suggest that Indian cancer registries take appropriate steps to resolve this impediment to both epidemiologic research and healthcare planning.

We were able to access the data from the first All India Report on Cancer Incidence in India published by the National Cancer Registries Program, which covers data up to year 1997 as well as the updated data available from some

individual registries through their 2001 reports (Nandakumar et al., 2004). A more recent report based on data from the population-based registries for 1999-2000 has been published by the National Cancer Registries Program, which also has published information on cancer cases diagnosed in areas beyond those served by the registries (Nandakumar et al., 2005). However, we chose to use the published data for reasons of accessibility by other interested parties.

In conclusion, unlike the observed similarities in both overall incidence and stage-at-diagnosis in the US, incidence and stage-at-presentation of breast cancer and prostate cancer in India differ notably from each other. The nearly three-fold difference in the proportion of prostate versus breast cancer cases detected in early stages (stage I and II) correlates with the three-fold difference observed in the age-standardized incidence rates of prostate and breast cancers. This suggests that the actual difference in the incidence rates of these two cancers in India may not be as high as the observed incidence rates would indicate. In fact, to a large extent, they may reflect differences in stage at initial presentation (and corollary issues such as seeking care because of signs and symptoms of disease). This, in turn, may be a concomitant of the paucity of programs aimed at early detection and very uneven distribution of wealth (Dasgupta, 1995; Purohit, 2004).

Both prostate and breast cancers can be detected in early stages by screening tests; e.g., prostate specific antigen (PSA) screening for prostate cancer and mammography for breast cancer, that are widely used in the West. Despite its shortcomings (Lehrer et al., 2002; Drake et al., 2006), PSA is the most commonly used and clinically useful tumor marker in the diagnosis of prostate cancer (Saw & Aw, 2000). The prostate cancer mortality rate has decreased slightly in the US over the past decade, and it is suggested that a primary reason may be increased use of the PSA test to detect prostate cancer early, especially in men with virulent disease (Chu et al., 2003). One concern, however, is that very indolent diseases that are picked up by PSA screening are not interesting from an epidemiologic perspective (Hardie et al., 2005; Johansson et al., 2004; von Eschenbach, 1996). Another is that detection of these cancers also creates economic and ethical dilemmas (Klotz, 2005; Lefevre, 1998), especially regarding treatment.

While large-scale, population-based screening for prostate cancer and breast cancer in India is infeasible, instituting small-scale demonstration projects would serve two purposes. First, it would allow us to test the effect of down staging on incidence. Second, if conducted on a large scale, it would provide a 'platform' on which observational epidemiologic studies could be conducted for research into etiologic factors that may be operative in a country in the process of an epidemiologic transition. Well-conceived and designed research would deepen our understanding of the underlying causes of differences in observed rates of these (and other) cancers across distinct areas (e.g., urban vs. rural). Third, it would allow an estimation of how many breast and prostate cancers might be prevented entirely.

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