RESEARCH COMMUNICATION

Decreasing Trend in the Incidence of Stomach Cancer in Mumbai, India, during 1988 to 1999

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Abstract

The time trend in incidence of stomach cancer in males and females in Mumbai, India during 1988 to 1999 was estimated using data collected by the Bombay Population-based Cancer Registry. During the 12-year period, a total of 3657 stomach cancer cases (3.9% of all cancers) were registered by the Bombay Population-based Cancer Registry of which 2467 (5.1% of all male cancers) were in males and 1184 (2.6% of all female cancers) in females. For evaluation of the trend, we applied a linear regression model based on the logarithm of the observed incidence rates. The annual percentage changes were also computed for the incidence rates for evaluating the time trend. A statistically significant decreasing trend in the overall age-adjusted incidence rates of stomach cancer was observed during the period 1988 to 1999, with an yearly decrease of 4.44% in males and 2.56% in females. This decrease was most striking in males in the age groups 40-59 and 60+, and in females only in the age group 40-59. The probability estimates indicated that one out of every 92 men and one out of every 187 women will contract a stomach cancer at some time in their whole life and 95% of the chance is after his or her 40th birthday. The decreasing trend in the age-adjusted incidence rates of stomach cancer in both the sexes indicates that there is a critical change in the etiology of this cancer. The findings may provide clues relating to various life-style and environmental changes impacting on stomach cancer incidence.

Key Words: Trend - incidence - stomach cancer

Asian Pacific J Cancer Prev, **5**, 169-174

Introduction

Stomach cancer is the fourth most common cancer in incidence and the second leading cause of cancer mortality in the world, accounting for an estimated 876,340 new cancer cases and 646,567 deaths worldwide in 2000 (Ferlay et al. 2002).

Analysis of time-related changes occurring in cancer incidence represents an essential tool for monitoring the effectiveness of the health system on cancer control in a specific area. Cancer incidence trends may reflect modifications both in the exposures to carcinogens and in improvement in diagnostic ascertainment.

Worldwide, the incidence trend of stomach cancer is declining, pointing to a critical environmental component in its etiology. Although the specific reason for this decline is unknown, the increased consumption of fruits and vegetables and the decreased intake of salty foods, both at least partially resulting from improved methods in food preservation and storage, are often credited. The International Agency for Research on Cancer (IARC) has acknowledged Helicobacter pylori as a major causal factor in the etiology of stomach cancer worldwide (IARC 1994). It is estimated that 47% of gastric cancers occurring in developing countries and 35% in industrialized countries are attributable to this bacterium (Parkin et al. 1999).

Although incidence rates decreased during the second half of the twentieth century, adenocarcinoma of the stomach still contributes substantially to cancer deaths in the western world (Thomas and Sobin 1995, Levi et al. 1996, Aragones et al. 1997).

Stomach cancer is much more common in certain Asian, Central European, Central American, and South American countries, especially Japan, Chile, Costa Rica, Hungary, and

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Poland. The highest incidence of stomach cancer occurs in Japan and Eastern Asia; by contrast, its incidence is relatively low in Western Europe (Parkin et al. 1999).

In the current study we provide the population-based incidence trend of stomach cancer in Mumbai, India during 1988 to 1999.

Materials and Methods

The Bombay Population-based Cancer Registry was established in 1963 as a unit of the Indian Cancer Society at Mumbai, India with the aim of obtaining reliable morbidity data on cancer, from a precisely defined urban population (covers 12 million inhabitants) (Greater Mumbai). The majority of hospitals in the city are maintained by the Municipal Corporation and the State Government, which are basically responsible for conducting public health and medical services in the city

All malignant tumors including those where the pathologist may have merely suspected a malignant change are registered. Cancer cases where the death certificate is the only source of information are also included. Patients, in whom cancer has been ruled out or has not yet been diagnosed, are omitted from our register.

We utilize the coding system devised by the World Health Organization using code numbers 140-208 as published in the manual of the International Classification of Diseases, Injuries and Causes of Death (WHO 1977). We also utilize the International Classification of Diseases for Oncology (WHO 1976), (ICD-O) simultaneously, for coding the primary site.

During the 12-year period, 1988 to 1999, a total of 3657 stomach cancer cases (3.9% of all cancers) were registered by the Bombay Population Based Cancer Registry of which 2467 (5.1% of all male cancers) were males and 1184 (2.6% of all female cancers) were females.

For population based cancer registries, the indicators ' proportion of deaths in period', 'proportion of death certificate only' and 'stability of age adjusted incidence rates' can determine the completeness of coverage of data. The indicators like 'proportion of cases registered after histological verifications', 'proportion of cases where age is not known', flattering of age incidence curve', and proportion of other and unspecified neoplasms can through some light on the quality of the data collected by the registry. In Bombay Cancer Registry data, the proportion of deaths in period is 52%, proportion of death certificate only is about 6% - which is quite low, and comparison of age adjusted incidence rate over the recent years does not show any statistically significant change. These facts indicate that the Bombay Cancer Registry data is complete. In Bombay Cancer Registry data, the percentage of histologic confirmation is about 85% - which is quite high, the proportion of age not known is only 1% - which is also very low, these indicators show that the quality of Bombay Cancer Registry data is reasonably good (Yeole 2001).

Population data was estimated from the 1981 and 1991 census reports (as on 1st March). The estimates for the years 1988 through 1999 (as on 1st July) were obtained by assuming a geometric rate of growth for each age group and sex. Since our definition of a resident differs from the criteria used in the population census, we have corrected our population estimates by eliminating all migrants whose duration of residence in Mumbai was less than one year.

Age-adjusted rates were computed using world population as standard (Plummer 1997). For evaluation of incidence trends we have used a linear regression analysis based on the logarithm of the observed incidence rates.

Table 1. Number of Incident Cases of Stomach Cancer with Crude (CR) and Age Adjusted (AAR) Rates per 100,000 Population by Broad Age Group with Annual Percentage Changes in CR and AAR, 1988 to 1999, Males

	Age group											
	00-39			40-59			60+			Total (All ages)		
Year	N	CR	AAR	N	CR	AAR	N	CR	AAR	N	CR	AAR
1988	13	0.3	0.3	86	9.3	10.3	97	46.8	48.6	196	3.8	7.7
1989	17	0.4	0.4	74	7.9	8.7	89	42.2	44.6	180	3.4	7.0
1990	16	0.4	0.3	100	10.5	11.3	103	48.0	50.0	219	4.1	8.1
1991	17	0.4	0.4	85	8.8	9.9	105	48.2	50.6	207	3.8	7.9
1992	23	0.5	0.5	79	8.0	8.8	104	47.0	49.4	206	3.7	7.6
1993	14	0.3	0.3	94	9.4	10.4	94	41.7	43.6	202	3.6	7.2
1994	17	0.4	0.3	80	7.9	8.8	106	46.3	48.6	203	3.6	7.4
1995	12	0.3	0.2	86	8.0	8.8	115	40.0	42.1	213	3.7	6.6
1996	16	0.4	0.3	106	9.5	10.2	123	38.4	40.1	245	4.1	6.8
1997	14	0.3	0.2	76	6.7	7.3	111	32.6	33.9	201	3.3	5.4
1998	19	0.4	0.3	86	7.4	8.0	111	30.8	31.9	216	3.5	5.4
1999	17	0.4	0.3	73	6.1	6.7	89	23.3	23.2	179	2.9	4.2
1988-1999	195	0.4	0.3	1025	8.3	9.1	1247	40.4	42.2	2467	3.6	6.8
APC		-0.03^{ns}	-3.31^{ns}		-2.81*	-2.95**		-5.02***	-5.24***		-1.34^{ns}	-4.44***

^{ns} not significant, * significant at the .05 level, ** significant at the 0.01 level, *** significant at the 0.001 level

Table 2. Number of Incident Cases of Stomach Cancer with Crude (CR) and Age Adjusted (AAR) Rates per 100,000 Population by Broad Age Group with Annual Percentage Changes for CR and AAR, 1988 to 1999, Females

	Age group											
	00-39			40-59			60+			Total (All ages)		
Year	N	CR	AAR	N	CR	AAR	N	CR	AAR	N	CR	AAR
1988	13	0.4	0.4	46	7.4	8.5	42	20.9	20.9	101	2.4	4.3
1989	17	0.5	0.1	35	5.5	6.1	33	16.1	16.0	85	2.0	3.4
1990	17	0.5	0.2	39	6.0	6.4	39	18.6	18.2	95	2.2	3.7
1991	5	0.1	0.1	33	5.0	5.7	48	22.4	22.2	86	1.9	3.7
1992	8	0.2	0.2	42	6.2	6.5	47	21.4	21.7	97	2.1	3.9
1993	13	0.3	0.4	34	4.9	5.3	34	15.1	15.2	81	1.7	3.0
1994	14	0.4	0.4	33	4.7	4.7	54	23.5	23.6	101	2.1	3.8
1995	12	0.3	0.3	33	4.2	4.5	47	17.4	17.2	92	1.9	3.0
1996	7	0.2	0.1	46	5.6	5.9	66	22.7	22.3	119	2.4	3.8
1997	13	0.3	0.3	53	6.2	6.5	53	17.3	17.3	119	2.3	3.5
1998	17	0.4	0.3	41	4.6	4.9	66	20.6	20.5	124	2.4	3.5
1999	10	0.2	0.2	31	3.4	3.5	43	12.7	12.7	84	1.6	2.3
1988-1999	146	0.3	0.3	466	5.3	5.7	572	19.1	19.0	1184	2.1	3.5
APC		-2.84^{ns}	+2.23^{ns}		-3.63*	-4.33**		-1.35ns	-1.33^{ns}		-0.50^{ns}	-2.56*

^{ns} not significant, *significant at the .05 level, **significant at the 0.01 level, ***significant at the 0.001 level

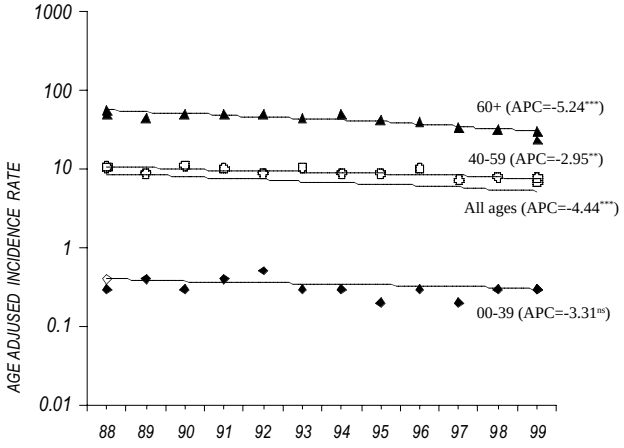
Logarithmic transformation was preferred specifically because this facilitates the comparison of trends at varying incidence levels that is where the trends at different ages are examined. A model that fits this data is the logarithm $Y=AB^x$ which represents a linear regression model, where Y is the estimated incidence rate per 100,000 of the population and x is the calendar year minus the initial year (1988) for the current data. A therefore represents the estimated rate of the initial year and (B-1)*100 gives the average annual percentage change in the incidence rate, during the period.

The cumulative incidence rate is a summary measure of the experience of a population over a longer time span or age-interval. It is obtained by summing up the age-specific incidences for each year in the defined age-interval and then expressed as a percentage. Since age-specific incidence rates are usually computed for five year age intervals, the cumulative incidence rate between birth to 75+ years of age is, 5 times the sum of the age-specific incidence rates calculated over five year age-groups. The cumulative incidence rate is a directly standardized incidence rate and a good approximation to the actuarial or cumulative risk. Reason for interest in the cumulative incidence rate is that it has a useful probabilistic interpretation. Another advantage is that as a form of direct age standardization, the arbitrariness in choosing a standard population is removed. The probability of getting a specific cancer, expressed in terms of 'one in every n persons' was computed by reciprocating estimated cumulative incidence rates expressed as percentages.

Results

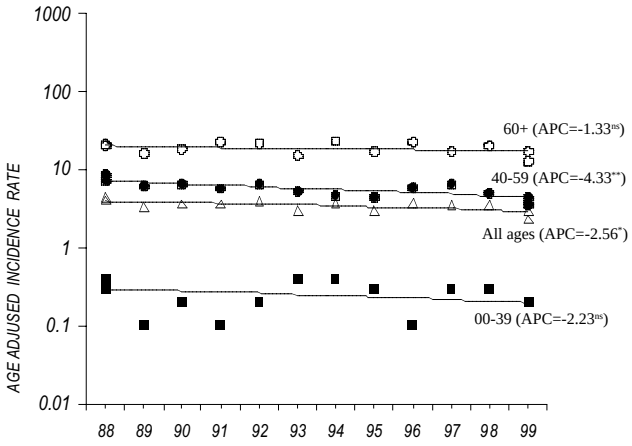
During the 12 year period, 1988 to 1999, the crude and age-adjusted incidence rates of stomach cancer were 3.6 and 6.8, respectively, for males and 2.1 and 3.5, respectively, for females per 100,000 population. The age-adjusted values for different age groups 00-39, 40-59 and 60 were 0.3, 9.1 and 42.2, respectively, for males and 0.3, 5.7 and 19.0, respectively, for females per 100,000 population.

A statistically significant ($p<0.001$ for males and $p<0.05$ for females) decreasing trend in the overall age-adjusted incidence rates of stomach cancer was observed during the period 1988 to 1999, with an yearly decrease of 4.44% in males and 2.56% in females and this decrease was most striking in males in the age groups, 40-59 and 60+, while in females only in the age group 40-59 (Tables 1 & 2, Figs 1 & 2). The decrease in the overall crude incidence rates for



^{ns} not significant, *significant at the .05 level, **significant at the 0.01 level, *** significant at the 0.001 level

Figure 1. Trends in Age adjusted Rates (AAR) of Stomach Cancer Incidence at Different Age Groups and at all Ages with Corresponding Annual Percentage Changes, during 1988 to 1999, Males



ns not significant, *significant at the .05 level, **significant at the 0.01 level, *** significant at the 0.001 level

Figure 2. Trends in Age Adjusted rates (AAR) of Stomach Cancer Incidence at Different Age Groups and at All Ages with Corresponding Annual Percentage Changes, during 1988 to 1999, Females

stomach cancer was not significant in both the sexes (Tables 1 & 2).

The probability estimates indicated that one out of every 92 men and one out of every 187 women will contract a stomach cancer at some time in their whole life and 95% of the chances are after his or her 40's. From the estimated cumulative incidence rate percentages for males, it has been evident that 1.13% of the male population will get a stomach cancer at some time in their whole life and 0.91% out of this 1.13% who get a stomach cancer belong to the age of more than 60 years, 0.20% will be in the age range 40-59 years and only 0.02% in the age 00-39 years. From the estimated cumulative incidence rate percentages for females, it has been evident that 0.55% of the female population will get a stomach cancer at some time in their whole life and 0.41% out of this 0.55% who get a stomach cancer belong to the age of more than 60 years, 0.12% will be in the age range 40-59 years and only 0.02% in the age 00-39 years (Table 3 & 4).

Discussion

As per the Bombay Population-based Cancer Registry data, stomach cancer ranks 5th in all male cancers and 7th in all female cancers with respect to age-adjusted incidence rates (Bombay Cancer Registry 2003). A declining trend in the overall age-adjusted incidence rates of stomach cancer was observed during the period 1988 to 1999, with an yearly decrease of 4.44% in males and 2.56% in females and this decrease was most striking in males in the age groups, 40-59 and 60+, while in females only in the age group 40-59. The probability estimates indicated that one out of every 92 men and one out of every 187 women in Mumbai, India will contract a stomach cancer at some time in their whole life and 95% of the chances are after his or her 40's.

The age-adjusted incidence rates of stomach cancer in both males and females were less than one twelfth of that seen in Japan (78 per 100 000 for men) and other high risk countries. Etiological factors for the incidence of stomach cancer in India are not well known. Tobacco chewing, smoking and alcohol drinking have not been found as risk factors for stomach cancer (Rao et al. 2002). Consumption of dry fish, spicy food, high consumption of chili, high-temperature food and infection with Helicobacter pylori increases the risk of stomach cancer in India (Bhasin et al. 1999, Mathew et al. 2000). The International Agency for Research on Cancer (IARC) has acknowledged Helicobacter pylori as a major causal factor in the etiology of stomach cancer worldwide (IACR 1994).

Table 3. Cumulative Incidence Rate Percent (CIRP) and Life Time Risk Expressed as One in Every 'n' Persons (LTR), at Different Age Groups and for all Ages for Stomach Cancer, 1988 to 1999, Males

	Age group							
	00-39		40-59		60+		Total (All ages)	
Year	CIRP	LTR	CIRP	LTR	CIRP	LTR	CIRP	LTR
1988	0.01	6920	0.23	435	1.04	96	1.28	78
1989	0.02	5140	0.19	521	0.98	102	1.19	84
1990	0.02	6333	0.24	416	1.06	94	1.32	76
1991	0.02	5298	0.22	454	1.08	92	1.32	76
1992	0.03	4047	0.20	523	1.08	92	1.30	77
1993	0.01	7035	0.23	433	0.93	108	1.17	85
1994	0.02	5320	0.20	507	1.06	94	1.28	78
1995	0.01	8810	0.20	513	0.93	108	1.13	88
1996	0.02	6815	0.22	456	0.89	112	1.12	89
1997	0.01	7665	0.16	622	0.73	136	0.91	110
1998	0.02	5986	0.17	587	0.70	143	0.89	113
1999	0.02	6782	0.15	665	0.48	207	0.65	155
1988-1999	0.02	6346	0.20	511	0.91	115	1.13	92

Table 4. Cumulative Incidence Rate Percent (CIRP) and Life Time Risk Expressed as one in Every 'n' Persons (LTR), at Different Age Groups and for all Ages for Stomach Cancer, 1988 to 1999, Females

	Age group							
	00-39		40-59		60+		Total (All ages)	
Year	CIRP	LTR	CIRP	LTR	CIRP	LTR	CIRP	LTR
1988	0.02	4969	0.19	517	0.44	227	0.65	153
1989	0.03	3729	0.14	743	0.37	269	0.53	188
1990	0.03	3971	0.14	735	0.41	245	0.57	176
1991	0.01	13979	0.13	761	0.45	222	0.59	170
1992	0.01	8305	0.14	739	0.48	217	0.61	164
1993	0.02	5438	0.11	884	0.35	288	0.48	209
1994	0.02	5228	0.10	1034	0.52	191	0.64	157
1995	0.02	6798	0.10	1045	0.38	279	0.47	213
1996	0.01	12410	0.13	783	0.48	218	0.60	168
1997	0.01	7060	0.14	727	0.35	283	0.51	198
1998	0.02	5766	0.10	1007	0.45	223	0.57	177
1999	0.01	9411	0.02	1341	0.28	355	0.37	272
1988-1999	0.02	7255	0.12	860	0.41	251	0.55	187

Worldwide, a decreasing trend in the incidence of stomach cancer has been reported. The reasons for this dramatic decline are not completely known but may be related to increased use of refrigeration for food storage, and decreased use of salted and smoked foods. Cancer of the stomach has declined in men and women. A possible reason is reduced salt intake which has been identified as a risk factor for stomach cancer in many correlation and case-control studies. The daily intake of salt has decreased in most western countries, due to public health campaigns to reduce hypertensive diseases. Various hypotheses have been postulated for the causes of the changing the trend. A reduction in the rate of infection with Helicobacter pylori in Western countries over the past few decades could account for the decrease in incidence of distal gastric cancers (Parsonnet et al. 1992, Siman et al. 1997). One of the major reason that stomach cancer has become less common is the frequent use of antibiotics to treat infections in children. This can kill Helicobacter pylori that may be a major cause of this disease. Furthermore, The roles of Helicobacter pylori infection (Chow et al. 1998), alcohol, tobacco (Gammon et al. 1997, Vaughan et al. 1998, Ye et al. 1999) and of dietary and racial differences (Brown et al. 1998, Chalasani et al. 1998, Kamineni et al. 1999) have been studied, but thus far evidence is conflicting. An inverse relationship between upper gastric cancer and Helicobacter pylori infection has been reported (Chow et al. 1998). Epidemiologic evidence suggests that increased intake of fresh fruits and vegetables are associated with decreased stomach cancer rates. The exact etiology of the major changes in the epidemiology of gastric cancer remains unclear.

Monitoring of trends is important for evaluating changes in population lifestyle, environmental risks and health care effectiveness. These critical changes in the trend of stomach cancer may be important in identifying the possible causative factors for this cancer. Prevention of stomach cancer via eradication of Helicobacter pylori infection is being actively considered in several countries.

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