Introduction

The global burden of cancer continues to increase largely because of the aging and growth of the world population alongside an increasing adoption of cancer-causing behaviors, particularly smoking in economically developing countries. Across the globe, cancer is leading cause of death too with 7.6 million deaths (around 13% of all deaths) in 2008. Total 13% of the annual death worldwide is cancer related, and 70% of these are in the low- and middle-income countries. It is estimated that 7.4 million people died of cancer in 2004, and if current trends continue, 83.2 million more will have died by 2015. For public health intervention baseline data regarding frequency distribution of cancer in the population is necessary. The focus of the National Cancer Control Program of India has been on primary prevention by promoting tobacco control and genital hygiene; on secondary prevention by screening for cervical cancer, breast cancer, and oropharyngeal cancer; and palliative care. This study was carried out in Gandhinagar district in the state of Gujarat, India to provide the magnitude of cancer and different types of cancer. Another purpose was to study mortality of 10 most cancer sites in Gandhinagar district.

Materials and Methods

Cancer is not a notifiable disease in India. Therefore, active registration of cancer cases was done in this study. This population-based study was conducted by The Gujarat Cancer and Research Institute (GCRI) Ahmedabad. The geographical area of this study was

**ABSTRACT**

Background: This study examines major cancer sites among the population of Gandhinagar district, India during the year 2009-2011. Objective: To study leading cancer incidents and mortality and their age distribution in both sexes in Gandhinagar district. Materials and Methods: Primary data were collected from various sources and entered in computer and analyzed. Quality checks were done, and duplicate cases were eliminated. For mortality data, death registration units were contacted. Results: Total 2360 incident cases (1374 males and 986 females) and 736 mortality cases (464 males and 272 females) were recorded during the year 2009-2011 in Gandhinagar district. Among males, the leading sites were mouth, tongue, lung, esophagus, hypopharynx, and larynx, whereas in females they were breast, cervix, ovary, mouth, tongue and myeloid leukemia. Majority of cases were found in the age group of 35-64 years and the proportion in male and female in this age group was 62.51% and 71.05%, respectively. Conclusion: The study helps to understand the possible cancer patterns in Gandhinagar district. Foremost causes of cancer in leading sites in males were tobacco related, and the proportion of cancers associated with tobacco was 53% in our study. It highlights the possibility of easy and early detection of cancers, especially by oral cancer screening in the population. Further, the findings highlight the need of cancer cervix and breast screening among women at regular intervals through camp approach in the community, as these are the most common sites (40% of female cancers). Keywords: Population based cancer registry, age, gender, incidence, mortality, Mortality/incidence% (M/I%) ratio

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Gandhinagar district of Gujarat State, India. Gandhinagar district has an area of 2163 square kilometres. The district includes 4 talukas — Gandhinagar, Kalol, Mansa, Dehgam and has 216 villages. All new cancer cases and mortality due to cancer cases found in Gandhinagar district between 1st January 2009 and 31st December 2011, for a period of 3 years were included in the study. All the cancer cases were collected by trained cancer registry staff from various sources of registration from government hospitals, private hospitals, nursing homes, and diagnostic laboratories, etc. The record files maintained by various departments of each hospital such as pathology, hematology, radiology, and the various specialized surgical and medical wards were also examined. The essential details obtained for each patient was cross-checked with the information collected from various departments of the collaborating hospitals to ensure completeness of records. Details of diagnostic and therapeutic information given by the various sources were entered in the computer. Malignant neoplasms were classified and coded as per WHO Manual.(5) International Classification of Diseases for Oncology (ICD-O-III) had been used for coding of microscopically verified reports of pathology.(6) In this study, the tobacco-related cancers (TRCs) were classified as per the International Agency for Research on Cancer (IARC) monographs on overall evaluations of carcinogenicity (IARC, 1987). The anatomical sites associated with the use of tobacco (along with corresponding ICD-10 codes) were lip (C00), tongue (C01-C02), mouth (C03-C06), pharynx (C10 and C12-C14), esophagus (C15), larynx (C32), lung (C33-C34), and urinary bladder (C67).(7) Data collection was done from different hospitals, and care was taken not to include the entries of same patient attending different hospitals. For collection of mortality data, help was taken from Birth and Death Registrar division of Gandhinagar district office. The percentages of male and female cancer patients from total cancer patients were calculated. Age group and gender-wise distribution for leading cancer incidence and mortality were also calculated. The crude incidence rate (CIR), age-specific incidence rate (ASpR), and age-adjusted incidence rate (AAR) and mortality/incidence percentage (M/I%) ratio were used for analysis. The CIR was calculated by dividing total number of new cases registered during a year by corresponding population of that year and multiplying the result by 100,000. ASpR refers to the rate obtained by dividing the total number of cancer cases by the corresponding estimated population in that age group and multiplying by 100,000. As age increases, the incidence of cancers also increases; therefore, with an increase in the median age of population, the cancer incidence also increases in the community. In order to make the rates of cancer comparable between two populations or countries, the 5-year age distribution of the world standard population was taken into account to obtain the AARs.(6) M/I% ratio is calculated by dividing total cancer mortality by total cancer incidence of that year and multiplying the result by 100.

Statistical analysis

The statistical software (EPI Info. Version 7) was used for data analysis. Chi-square test was performed to access the association of gender with age groups. \( P \) value <0.05 was considered to be statistically significant.

Results

Morbidity

During the 3-year period from 1st Jan 2009 to 31st December 2011, total of 2360 cancer cases (1374 males and 986 females) were registered in Gandhinagar district. Male and female incidence ratio was 1.4:1. Figure 1 describes the percentage of population and cancer cases by broad age group and gender. About 2.3% of cases occurred in Pediatric age group of 0-14 years, 9.49% in 15-34 years, 66.19% in the truncated age group of 35-64 years, and 22.03% in older age group in both the genders. In other words, about 88% of cancers occurred after age of 34 years, whereas total population above age of 34 years accounted for about 34% in both sexes thus indicating need for control measures to prevent cancer problem among general population at the very young age group. The CIR was calculated by dividing the total number of new cases registered during a year by corresponding population of that year and multiplying the result by 100,000. ASpR refers to the rate obtained by dividing the total number of cancer cases by the corresponding estimated population in that age group and multiplying by 100,000. As age increases, the incidence of cancers also increases; therefore, with an increase in the median age of population, the cancer incidence also increases in the community. In order to make the rates of cancer comparable between two populations or countries, the 5-year age distribution of the world standard population was taken into account to obtain the AARs.(6) M/I% ratio is calculated by dividing total cancer mortality by total cancer incidence of that year and multiplying the result by 100.

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beginning of truncated age group. The age distributions showed that maximum number of cases were in the 35-64 years of age group. Proportion of cancer cases was 62.59% and 71.20% in males and females, respectively, in this age group. The rate of cancers was reduced at the extremes of ages in both the sexes. There was an overall female preponderance in age group 35-64 years, but male preponderance was found in age above 65 years. This difference in the occurrence of cancers in different age group in men and women was statistically highly significant ($P < 0.000$).

During the year 2009-2011, the major 10 leading sites in males constituted 61.50% of total male cancers, whereas it constituted 69.07% of total female cancers. Table 1 showed the distributions of leading malignancies in males and females. The leading sites of cancer (with relative proportion in parentheses) in males were mouth (14.56%) followed by tongue (13.17%), lung (8.37%), esophagus (6.26%), hypopharynx (4.22%), larynx (3.78%), myeloid leukemia (3.35%), lymphoid leukemia (2.69%), tonsil (2.62%), and prostate (2.47%). The respective CR and AAR per 100,000 population for above sites (given in parentheses) were: Mouth (7.80 and 9.05), tongue (7.06 and 9.15), lung (4.49 and 6.74), esophagus (2.98 and 4.24), hypopharynx (2.26 and 2.91), larynx (1.79 and 2.00), myeloid leukemia (1.44 and 1.74), tonsil (1.40 and 2.03), and prostate (1.33 and 2.14). The leading sites among females were breast (24.85%) followed by cervix uteri (15.11%), ovary (5.38%), mouth (4.77%), tongue (4.26%), myeloid leukemia (4.26%), esophagus (3.45%), hypopharynx (2.94%), lung (2.03%), and skin (2.03%). The respective CR and AAR per 100,000 populations for above sites (given in parentheses) were: Breast (10.53 and 11.33), cervix uteri (6.82 and 7.41), ovary (2.28 and 2.46), mouth (2.02 and 2.26), tongue (1.81 and 1.93), myeloid leukemia (1.81 and 1.67), esophagus (1.46 and 1.63), hypopharynx (1.25 and 1.39), lung (0.86 and 1.05) and skin (0.86 and 0.99). Tobacco-related cancers in males constituted 58.2% of total cancers in them, whereas TRCs in female were 25.3% of total cases in women. Thus, tobacco was observed to be the most important identified cause of cancer in this study also. Tobacco chewing has resulted in a huge burden of oral cancers and oral pre-cancerous condition. There are various other forms of tobacco use peculiar to certain geographic regions of India and these need special attention.(9)

**Mortality**

During the year 2009-2011, total 736 deaths (464 males and 272 females) were observed in Gandhinagar (PBCR) district. The proportion of leading cancer mortality in males and females was 64.44% and 65.07%, respectively. Table 2 shows the distribution of leading cancer mortality in males and females, Gandhinagar (PBCR), (2009-2011).
cancer mortalities in both the sexes. The leading cancer mortalities in males were tongue (14.01%), lung (12.07%), mouth (9.91%), esophagus (7.97%), hypopharynx (5.17%), pharynx (3.66%), myeloid leukemia (3.45%), tonsil (3.02%), stomach (2.59%) and larynx (2.59%). The respective crude mortality rate (CMR) and age-adjusted mortality rate (AAMR) per 100,000 populations for above sites (given in parentheses) were: Tongue (2.54 and 3.28), lung (2.19 and 3.40), mouth (1.79 and 2.14), esophagus (1.44 and 1.97), hypopharynx (0.94 and 1.34), pharynx (0.66 and 0.95), myeloid leukemia (0.62 and 0.78), tonsil (0.55 and 0.79), stomach (0.47 and 0.68), and larynx (0.47 and 0.65). The leading cancer mortalities in females were breast (16.18%), cervix uteri (11.4%), esophagus (6.62%), ovary (5.88%), tongue (5.15%), myeloid leukemia (4.78%), mouth (4.41%), hypopharynx (4.04%), lung (3.31%), myeloid leukemia (3.31%). The respective CMR and AAMR per 100,000 populations for above sites (given in parentheses) were: Breast (1.89 and 1.96), cervix uteri (1.33 and 1.51), esophagus (0.77 and 0.89), ovary (0.69 and 0.75), tongue (0.60 and 0.67), myeloid leukemia (0.56 and 0.54), mouth (0.52 and 0.58), hypopharynx (0.47 and 0.54), lung (0.39 and 0.49), and lymphoid leukemia (0.39 and 0.42).

Discussion

Over a period of 3 years (2009-2011), the cancer cases among the males and females were 2360. Almost all the cases among males and females occurred in the age group 35-64 years as per the study. About half of the cases among men and one-fifth of cases among women pertaining to sites are mainly attributable to tobacco use. Overall, about one-third of cancers in India pertain to tobacco-related sites. This study also represents the same pattern. Oral cancer is a major problem in the Indian subcontinent as it ranks among the top three types of cancer in the country. In Gandhinagar, the leading cause of cancer-related deaths is due to tongue and lungs in males. Oral cancers are with high mortality. More than 1.4 million lung cancer deaths that occur annually worldwide are caused by tobacco and smoking. Tobacco is by far the single most important risk factor for cancer. Worldwide it has caused 22% of cancer deaths. In our study, TRC constitutes 58.41% of all cancer deaths in males.

In females, the breast cancer was the foremost concern. Cancer of breast had emerged as the leading site of cancer in most urban populations of India. In our study, we observed similar pattern. For the year 2007, there have been 82,000 estimated new cases of breast cancer in India. It is rapidly replacing cancer of cervix as the most important leading site of cancer among women. Figure 3 shows comparison of AAR with different PBCR for cancer of breast in females. Bangalore (36.1), Mumbai and Delhi (32.3) had higher AARs of female breast cancers among all PBCRs. In our study, AAR of female breast cancers was 11.3 per 100,000 population. Cervical cancer is the commonest malignancy among women in India over past two decades and second most common form of cancer in the world as a whole. All the urban PBCRs at Bangalore, Bhopal, Chennai, Delhi, and Mumbai have shown a statistically significant decrease in the AARs of this site of cancer.

India is a culturally diverse country with huge regional and rural-to-urban variation with respect to lifestyles and age-specific adult death rates. In Gandhinagar, the leading cause of cancer-related deaths is due to tongue and lungs in males. Oral cancers are with high mortality. More than 1.4 million lung cancer deaths that occur annually worldwide are caused by tobacco and smoking. Tobacco is by far the single most important risk factor for cancer. Worldwide it has caused 22% of cancer deaths. In our study, TRC constitutes 58.41% of all cancer deaths in males.

Breast cancer ranked first as the cause of cancer death and cervix uteri cancer is the second leading cause of death. For the year 2007, there have been 82,000 estimated new cases of breast cancer in India. It is rapidly replacing cancer of cervix as the most important leading site of cancer among women. Figure 3 shows comparison of AAR with different PBCR for cancer of breast in females. Bangalore (36.1), Mumbai and Delhi (32.3) had higher AARs of female breast cancers among all PBCRs. In our study, AAR of female breast cancers was 11.3 per 100,000 population. Cervical cancer is the commonest malignancy among women in India over past two decades and second most common form of cancer in the world as a whole. All the urban PBCRs at Bangalore, Bhopal, Chennai, Delhi, and Mumbai have shown a statistically significant decrease in the AARs of this site of cancer.

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cancer death for women in Gandhinagar district. In our study, cancer of breast and cervix constituted 27.57% of mortality in females. Worldwide, particularly in developing countries, cervical cancer remains the major cause of death in women accounting for an estimated 160,000 deaths every year. The AAR for cervical cancer has been reported to vary from 19 to 44 per 100,000 women in various cancer registries in India.

Mortality to Incidence percentage ratio (M/I% ratio) is another important indicator of completeness in general. In cancers with very poor survival, such as cancer of liver, the M/I% will be close to 1 (or 100%). Cancers with better survival like breast cancer would have figures less than one. The M/I ratio was highest among males in Barshi rural (71.8) and lowest in Delhi (13.2). Among females also Barshi rural registry showed highest M/I ratio (67.2) and lowest in Cachar district of Assam state (6.8) [Table 3].

Figures 2 and 3 show comparison of AARs, and Figure 4 shows comparison of age-adjusted mortality rates in Gandhinagar District with different PBCRs for cancer of mouth in males and cancer of breast in females as per National Cancer Registry Programme, Three-year report of PBCRs (2009-2011).

Conclusion

The TRCs represent the most preventable form of cancer in our society. Mortality rate due to TRC is 58.41% in male and 23.53% in female. The greatest impact to reduce the burden of cancer comes both from primordial and primary prevention. Further, screening for uterine cervix, oral and breast cancers could have a significant effect on reducing mortality from cancer. The screening programs conducted every 5 years in several countries have been able to reduce the incidence and mortality from cervical cancer by 60% as observed by Hakama et al.

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Table 3: Number of incidence cases, number of mortality cases and mortality to incidence percentage ratio (M/I% ratio) of all sites of cancers in Gandhinagar District in comparison with the other registries of India

| Registry                        | Male |            |        | Female |            |        |
|---------------------------------|------|------------|--------|--------|------------|--------|
|                                 | Incidence | Mortality | M/I%   | Incidence | Mortality | M/I%   |
|---------------------------------|--------|------------|--------|--------|------------|--------|
| Gandhinagar district (2009-2011)| 1374   | 464        | 33.8   | 986    | 272        | 27.6   |
| Bangalore (2008-2009)           | 6026   | 2161       | 35.9   | 7389   | 1923       | 26.0   |
| Ahmedabad urban (2009-2010)     | 4533   | 1159       | 25.6   | 3460   | 714        | 20.6   |
| Barshi Rural (2009-2010)        | 273    | 196        | 71.8   | 302    | 203        | 67.2   |
| Delhi (2008-2009)               | 15189  | 2001       | 13.2   | 13838  | 1455       | 10.5   |
| Cachar district (2009-2010)     | 1579   | 210        | 13.3   | 1263   | 86         | 6.8    |

Figure 4: Comparison of age-adjusted mortality rates in Gandhinagar district with different PBCRs for all sites in males and females.

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