EPIDEMIOLOGY, SURVEILLANCE, DIAGNOSIS AND TREATMENT OF CANCER CASES IN RELATION WITH LIFESTYLE, BEHAVIOUR AND ENVIRONMENTAL FACTORS

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CERTIFICATE

This is to certify that the thesis "**Epidemiology, surveillance, diagnosis and treatment of cancer cases in relation with lifestyle, behaviour and environmental factors**" incorporate the results of investigation carried out by the candidate himself and analyzed in the Department of Zoology, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara.

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LIST OF ABBREVIATIONS

(*Well-known abbreviations in general use are not included*)

AAMR	-	Age Adjusted Mortality Rate
A"AR/ASR	-	Age Adjusted or Standardized Incidence Rate
ASpR	-	Age Specific Incidence Rate
CIR	-	Crude Incidence Rate
CMR	-	Crude Mortality Rate
DCO	-	Death certificate Cases Only
GCRI	-	Gujarat Cancer and Research Institute
IARC	-	International Agency for Research on Cancer
ICDO	-	International Classification of Diseases for Oncology
M/I	-	Mortality to Incidence ratio
NCRP	-	National Cancer Registry Programme
PBCR	-	Population Based Cancer Registry
RCR-AD	-	Rural Cancer Registry-Ahmedabad District
TMR	-	Truncated Mortality Rate
TR	-	Truncated Incidence Rate
USNTP	-	United States National Toxicology Programme
WHO	-	World Health Organization

INTRODUCTION

The fundamental objective of science is to make human life qualitatively better, free of diseases and sufferings. Despite the fact that the modern, industrialized and scientifically competent world has successfully eliminated infectious diseases, the fear of cancer as a killer disease has not subsided.

Cancer is a class of diseases characterized by uncontrolled cell growth. Normally, cells grow and divide to produce more cells only when the body needs them. Sometimes, however, cells become abnormal and keep dividing to form more cells without any control or order, creating a mass of excess tissue called a tumor or neoplasm. The process by which a cell loses its ability to remain constrained in its growth properties is called transformation. If transformed cells stay together in a single mass, the tumor is said to be benign. Benign tumors are usually not life threatening, and their surgical removal generally results in a complete cure. If the cell of a tumor can invade and disrupt surrounding tissues, the tumor is said to be malignant and is identified as cancer. Cells from malignant tumors can also break off and move through the blood system or lymphatic system, forming new tumors at other locations in the body. The spreading of malignant tumor cells throughout the body is called metastasis. Malignancy can result in death because of damage to cortical organs, starvation, secondary infection, metabolic problems, secondary malignancies and/or hemorrhage.

Cancer has been one of the major causes of death in last couple of centuries and is the second major cause of non communicable deaths, worldwide (Shibuya *et al*., 2002). The varied geographical distribution of human population has never been a limiting factor for the incidence of cancer. People belonging to nations from third world, developing or the developed countries, all get victimized. This burden of cancer is increasing worldwide despite advances in diagnosis and treatment (Ganjewala, 2009). According to recent statistics, cancer accounts for about 23% of the total deaths in world and is the second most common cause of death after heart disease (Jemal *et al.,* 2007; Aggarwal *et al.*, 2008; Ganjewala, 2009). Approximately one million cases of cancer were reported throughout the world in 1990 (Murthy *et al.,* 1990), while the figure increased to an astonishing 10 millions in the year 2000 (Ganjewala, 2009). Cancer accounted for 7.4 million deaths (around 13% of all deaths) in 2004. More than 70% of all cancer deaths occurred in low- and middle-income countries (WHO, 2010). By 2020, the world population is expected to have increased to 7.5 billion; of this number, approximately 15 million new cancer cases will be diagnosed with an estimated 12 million deaths (Bray and Moller, 2006; Salminen *et al.,* 2005).

In India, cancer is the second most common cause of death, growing at 11 percent annually. There are about 2-2.5 million cancer cases in the country with 7-9 lacs new cases added every year (Park *et al.,* 2009). One in five Indian men dies between age 30 and 69 due to tobacco-related cancers (Datta, 2010; WHO, 2010). In India, even though the most prevalent cancers- breast, cervical and oral cancers are largely preventable or treatable, more than 70% of the cases are detected at later stages when it is too late for effective treatment (Smith, *et al.,* 2009). As per WHO studies, the total mortality (males and females) due to cancer in India is estimated to reach 6,66,563 by 2015.

Many national and international agencies worldwide are striving to unravel the mechanisms underlying this dreaded disease. To name a few, IARC (International

Agency for Research on Cancer) and the USNTP (National toxicology program) are the most worthy agencies for human welfare. However, despite worldwide research, a specific drug for cancer is still elusive. Under such conditions, it becomes essential to study the epidemiology of cancers of varied types, their respective surveillance, diagnosis and finally their treatment schedules. The epidemiology of cancer is the study of the factors affecting cancer, as a way to infer possible trends and causes. Cancer surveillance provides a quantitative portrait of cancer and its determinants in a defined population. The core functions of cancer surveillance are the measurement of cancer incidence, morbidity, survival, and mortality for persons with cancer. It also includes the assessment of genetic predisposition, environmental and behavioral risk factors, screening practices, and the quality of care from prevention through palliation. Cancer surveillance tells us where we are in the effort to reduce the cancer burden and also generates the observations that form the basis for cancer research and interventions for cancer prevention and control (Adamo *et al.,* 2010). Cancer surveillance provides registered cases of cancer, estimated new cancer cases, symptoms related to cancer, mortality due to cancer, trends in the recorded number of cancer deaths etc. Such studies can be helpful in understanding potential risk factors of cancer and explore our options for modulating these risk factors.

Cancer is caused by both internal factors (such as inherited mutations, hormones, and immune conditions) and environmental/acquired factors (such as tobacco, diet, radiation, and infectious organisms). Only 5ï 10% of all cancers are due to an inherited gene defect (Aggarwal *et al.*, 2008). Although all cancers are a result of multiple mutations (Loeb and Loeb, 2000; Hahn and Weinberg, 2002), these mutations are due to interaction with the environment (Mucci *et al.,* 2001; Czene and Hemminki, 2002). A study was conducted in Utah to determine the frequency of cancers in first degree relatives (parents + siblings + offspring) so as to provide an age-adjusted risk ratio to first-degree relatives of cases compared with the general population. According to this study, the contribution of genetic

and environmental factors towards cancer risk was found to be 5-10% and 90-95% respectively (Aggarwal *et al.*, 2008).

These observations indicate that most cancers are not of hereditary origin and that lifestyle factors, such as dietary habits, smoking, alcohol consumption, and infections, have a profound influence on their development (Irigaray *et al.*, 2007). Although hereditary factors cannot be modified, the lifestyle and environmental factors are potentially modifiable. The lesser hereditary influence of cancer and the modifiable nature of the environmental factors point to the preventability of cancer. The important lifestyle factors that affect the incidence and mortality of cancer include tobacco, alcohol, diet, obesity, infectious agents, environmental pollutants, and radiation.

People are continuously exposed exogenously to varying amounts of chemicals that have been shown to have carcinogenic or mutagenic properties in experimental systems. Exposure can occur exogenously when these agents are present in food, air or water, and also endogenously when they are products of metabolism or pathophysiologic states such as inflammation. It has been estimated that exposure to environmental chemical carcinogens may contribute significantly to the causation of a sizable fraction, perhaps a majority, of human cancers, when exposures are related to "life-style" factors such as diet, tobacco, alcohol use etc. (Wogan *et al.,* 2004).

A brief overview of certain risk factors associated with cancer and diagnosis and treatment methods for cancer is given below:

RISK FACTORS

Lifestyle related risk factors

1. Tobacco: Cancer can be caused by smoking cigarettes, pipes, cigars, or bidis (which consist of small amounts of tobacco wrapped in the leaf of another plant, and are

commonly used in South Asia) and chewing of tobbaco (pan-masala). Tobacco smoke also contains some of the most deadly carcinogenic chemicals known, which include tobacco-specific nitrosamines NNN, NNK, NAT and NAB that are formed from natural components of the tobacco plant. All forms of tobacco produce cancer-causing smoke. Since 1986, further evidence has been published that showed that smoking tobacco can also cause cancer of the nasal cavity, paranasal sinuses and nasopharynx; stomach; liver; kidney; cervix, uteri; and adenocarcinoma of the esophagus and myeloid leukemia (Vineis *et al.,* 2004).

2. Alcohol: Regular alcohol consumption can have numerous consequences, beneficial or detrimental, on the health of the drinker. For example, light-to-moderate alcohol consumption may protect against certain types of heart disease and stroke. Conversely, heavy drinking has been associated with liver disease; cardiovascular disease; disorders of the digestive tract; and illness or death from alcohol-related injuries, motor vehicle crashes, and violence. Alcohol is associated with an increased risk of a number of cancers. 3.6% of all cancer cases and 3.5% of cancer deaths worldwide are attributable to consumption of alcohol (Boffetta *et al.*, 2006). Breast cancer in women is known to be associated with alcohol intake. Alcohol also increases the risk of cancers of the mouth, oesophagus, pharynx and larynx (WCRF & AICR, 2009). Alcohol consumption also is associated with primary liver cancer. This relationship is difficult to investigate in epidemiological studies, however, because it is more indirect. Thus, alcohol causes cirrhosis of the liver in a substantial proportion of heavy drinkers, which then can lead to liver cancer. In addition, heavy alcohol consumption can increase the drinker's risk for infection with the hepatitis C virus (HCV), which in turn can also result in liver cancer. The increased risk of cancer among heavy drinkers is primarily attributed to the alcohol (chemically referred to as ethanol) in alcoholic beverages. Thus, the risk tends to increase with the overall amount of ethanol consumed (Doll *et al*., 1999).
3. Diet: Diet and cancer are associated. While it is not yet possible to provide quantitative estimates of the overall risks, it has been estimated that 35 percent of cancer deaths may

be related to dietary factors (Doll and Peto, 1981). Almost all cancers (80ï 90%) are caused by environmental factors (Abdulla and Gruber, 2000) and 30ï 40% of cancers are directly linked to the diet (WCRF & AICR, 2009). Cancer rates in India are lower than those seen in Western countries, but are rising with increasing migration of rural population to the cities, increase in life expectancy and changes in lifestyles (Sinha *et al*., 2003).

4. Obesity: Over the past few decades the proportion of people with excess body weight has been increasing in both developed and less developed countries. In addition to an increase in the risk of cardiovascular disease and type II diabetes, excess body weight is directly associated with risk of cancer at several organ sites, including colon, breast (in postmenopausal women), endometrium, oesophagus, and kidney. In part, these associations with cancer risk may be explained by alterations in the metabolism of endogenous hormones including sex steroids, insulin, and insulin-like growth factors, which can lead to distortion of the normal balance between cell proliferations and differentiation. Avoidance of weight gain thus seems to be an important factor for cancer prevention (Bianchini *et al.*, 2002).

Environmental Factors:

1. Asbestos: Asbestos has been classified as a known human carcinogen (a substance that causes cancer) by the U.S. Department of Health and Human Services, the EPA, and the International Agency for Research on Cancer. People may be exposed to asbestos in their workplace, their communities, or their homes. If products containing asbestos are disturbed, tiny asbestos fibers are released into the air. When asbestos fibers are breathed in, they may get trapped in the lungs and remain there for a long time. Over time, these fibers can accumulate and cause scarring and inflammation, which can affect breathing and lead to serious health problems (ATSDR, 2009). Studies have shown that exposure to asbestos may increase the risk of lung cancer and mesothelioma (a relatively rare cancer of the thin membranes that line the chest and abdomen). Although rare,

mesothelioma is the most common form of cancer associated with asbestos exposure. In addition to lung cancer and mesothelioma, some studies have suggested an association between asbestos exposure and gastrointestinal and colorectal cancers, as well as an elevated risk for cancers of the throat, kidney, esophagus, and gallbladder (DeVita *et al.,* 2001; National Toxicology Program, 2005).

2. Air Pollution: Epidemiologic studies over the last 40 years suggest rather consistently that general ambient air pollution, chiefly due to the incomplete combustion of fossil fuels, may be responsible for increased rates of lung cancer. This evidence derives from studies of lung cancer trends, studies of occupational groups, comparisons of urban and rural populations, and case-control and cohort studies using diverse exposure metrics. Recent prospective cohort studies observed 30 to 50% increases in lung cancer rates associated with exposure to respirable particles (Cohen and Pope, 1995).

Radiation:

Cancer may occur following ionizing radiation exposure following a latent period averaging 20 to 40 years (James *et al*., 2006). Various malignancies may develop, most frequently basal-cell carcinoma followed by squamous-cell carcinoma (Suárez *et al*., 2007). Elevated risk is confined to the site of radiation exposure (Lichter *et al.*, 2000). Several studies have also suggested the possibility of a causal relationship between melanoma and ionizing radiation exposure (Fink and Bates, 2005). The degree of carcinogenic risk arising from low levels of exposure is more contentious, but the available evidence points to an increased risk that is approximately proportional to the dose received (Wakeford, 2004). Radiologists and radiologic technologists are among the earliest occupational groups exposed to radiation. It was the observation of the earliest radiologists that led to the recognition of radiation-induced skin cancer - the first solid cancer linked to radiation - in 1902 (Yoshinaga *et al.,* 2004). While the incidence of skin cancer secondary to medical ionizing radiation was higher in the past, there is also some evidence that risks of certain cancers, notably skin cancer, may be increased among more recent medical radiation workers, and this may be

related to specific or changing radiologic practices. Available evidence indicates that the excess risk of skin cancer lasts for 45 years or more following irradiation (Shore, 2001).

Infectious agents:

The epidemiology of several types of cancers indicate the involvement of several transmissible agents in their development, and in most cases, these seem to be viruses. The classic examples are Burkittôs lymphoma, nasopharyngeal carcinoma (Epstein-Barr Virus), hepatocellular carcinoma (Hepatitis B Virus), and cervical carcinoma (Human Papilloma Virus). Most of these cancers show substantial variations in their incidence in different parts of the world and in particular countries, they present significant health problems. Worldwide, infections account for up to 20% of all cancers. Although it has been known for decades that naturally acquired viral infections in animals could cause malignancy, the evidence in humans has accumulated more slowly (Evans and Mueller, 1990). With the advent of new molecular research tools; there is now strong evidence for the role of several viruses in human malignancy. Also, there is now ample evidence implicating infection with the *Helicobacter pylori* in the occurrence of gastric carcinoma and gastric lymphoma, and infection with *Schistosoma haematobium* in the occurrence of the squamous cell carcinoma of the urinary bladder (Oluwasola and Adeoye, 2005).

DIAGNOSIS

Most cancers are initially recognized either because signs or symptoms appear or through screening. Neither of these lead to a definitive diagnosis, which usually requires the opinion of a pathologist. People with suspected cancer are investigated with medical tests. These commonly include Microscopic examination (blood film, cytology, Histopathology), imaging (X-rays, CT scans, mammogram), laboratory tests (including tests for blood and tumor markers), genetic testing and endoscopy.

Diagnosis through imaging

Imaging is the process of producing pictures of body structures and organs for diagnosis. It is used to detect tumors and other abnormalities, to determine the extent of disease, and to evaluate the effectiveness of treatment. Imaging may also be used when performing biopsies and other surgical procedures. There are three types of imaging used for diagnosing cancer: transmission imaging, reflection imaging, and emission imaging. Each uses a different process.

1. Transmission imaging: X-rays, computed tomography scans (CT scans), and fluoroscopy are radiological examinations whose images are produced by transmission.
    - X-ray: X-rays are diagnostic tests that use invisible electromagnetic energy beams to produce images of internal tissues, bones, and organs on film. X-rays may be taken of any part of the body to detect a tumor (or cancer).
    - Computed tomography scan (Also called a CT scan or computed axial tomography or CAT scan.): A CT scan is a diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce cross-sectional images (often called slices), both horizontally and vertically, of the body. A CT scan shows detailed images of any part of the body, including the bones, muscles, fat, and organs. CT scans are more detailed than general X-rays.
    - Mammogram: A mammogram is an X-ray examination of the breast. It is used to detect and diagnose breast disease in women who either have breast problems such as a lump, pain, or nipple discharge, as well as for women who have no breast complaints. Mammography cannot prove that an abnormal area is cancerous, but if it raises a significant suspicion of cancer, a biopsy may be performed

2. Reflection imaging: Reflection imaging refers to the type of imaging produced by sending high-frequency sounds to the body part or organ being studied. These sound waves "bounce" off the various types of body tissues and structures at varying speeds,

depending on the density of the tissues present. The bounced sound waves are sent to a computer that analyzes the sound waves and produces a visual image of the body part or structure (Kailash *et al.*, 2008).

- Ultrasound: Ultrasound, or sonography, is the most commonly used type of reflection imaging. This technique uses high-frequency sound waves and a computer to create images, called sonograms, of blood vessels, tissues, and organs. Sonograms are used to view internal organs as they function and to assess blood flow through various vessels. Tumors in the abdomen, liver, and kidneys can often be seen with an ultrasound.

3. Emission imaging: Emission imaging occurs when tiny nuclear particles or magnetic energy are detected by a scanner and analyzed by computer to produce an image of the body structure or organ being examined. Nuclear medicine uses emission of nuclear particles from nuclear substances introduced into the body specifically for the examination.

    - Magnetic resonance imaging (MRI): MRI is a diagnostic procedure that uses a combination of a large magnet, radiofrequencies, and a computer to produce detailed images of organs and structures within the body. An MRI is often used to examine the heart, brain, liver, pancreas, male and female reproductive organs, and other soft tissues. It can assess blood flow, detect tumors and diagnose many forms of cancer, evaluate infections, and assess injuries to bones and joints (Harms, 1996).

- Positron emission tomography (PET): PET is a specialized radiology procedure used to examine various body tissues to identify certain conditions. PET may also be used to follow the progress of the treatment of certain conditions. PET is a type of nuclear medicine procedure. This means that a tiny amount of a radioactive substance, called a radionuclide (radiopharmaceutical or radioactive tracer), is used during the

procedure to assist in the examination of the tissue under study. Specifically, PET studies evaluate the metabolism of a particular organ or tissue, so that information about the physiology (functionality) and anatomy (structure) of the organ or tissue is evaluated, and so are its biochemical properties. Thus, PET may detect biochemical changes in an organ or tissue that can identify the onset of a disease process before anatomical changes related to the disease can be seen with other imaging processes such as computed tomography (CT) or magnetic resonance imaging (MRI).

Diagnosis through microscopic examination

Histopathology of tumour tissue (biopsy), cytological changes and blood cell morphology are examined under microscope to diagnose cancer.

- Biopsy: A biopsy is a medical test involving sampling of cells or tissues for examination. It is the surgical removal of tissue from a living subject to determine the presence or extent of a disease. The tissue is generally examined under a microscope by a pathologist, and can also be analyzed chemically. When an entire lump or suspicious area is removed, the procedure is called an excisional biopsy. When only a sample of tissue is removed with preservation of the histological architecture of the tissueôs cells, the procedure is called an incisional biopsy or core biopsy. When a sample of tissue or fluid is removed with a needle in such a way that cells are removed without preserving the histological architecture of the tissue cells, the procedure is called a needle aspiration biopsy (Sausville and Longo, 2005).
- Cytology: Cytology is becoming increasingly important in cancer detection and diagnosis. However, the ease with which cytology can be applied to uterine cancer detection in large populations is unfortunately not the same for other important sites. Mass screening of high risk groups has been attempted for cancer of the lung, urinary bladder, stomach, colon and oral cavity (Wilson and Jungner, 1968). For cytogenetics study, *in situ* hybridization technique is used for detection and diagnosis of human cancers and for detection of residual cancer cells. This approach allows individual

interphase cancer cells to be stained so that aberrations such as aneusomies, translocations, deletions, and gene amplification can be seen in the light microscope. This is accomplished using probes for repeated sequences found at the chromosome centromeres, whole chromosome probes, and/or probes for specific aberrant sequences (Gray and Pinkel, 1992).

- Blood smear: Blood smear is studied to determine if red blood cells (RBCs), white blood cells (WBCs), and platelets are normal in appearance and number, to distinguish between the different types of white blood cells and determine their relative percentages in the blood. It helps diagnose a range of deficiencies, diseases, and disorders involving blood cell production, function, and destruction. It may also be used to monitor cell production and cell maturity in diseases such as leukemia.

TREATMENT

The most common cancer treatments include surgery, radiation therapy, and chemotherapy. These therapies may be used either alone or in combination with other therapies. Palliative treatment is the treatment given to relieve symptoms of cancer such as pain. Other cancer treatment options include targeted therapy, immunotherapy, hormonal therapy, and stem cell/bone marrow transplantation.

Surgery

Surgery is frequently used to remove cancerous growths or obtain small samples of tissue for examination. For several types of cancer, surgical removal of a tumor may be sufficient to cure the patient. The likelihood of a surgical cure is dependent on the size, location, and stage of the disease. Surgery is often used in combination with radiation and/or chemotherapy. The choice of treatments depends on the type, location and size of the tumor (Abeloff *et al.,* 2008)

Radiation therapy

Radiation therapy uses high-energy radiation to shrink tumors and kill cancer cells (Lawrence *et al.,* 2008). X-rays, gamma rays, and charged particles are types of radiation used for cancer treatment. The radiation may be delivered by a machine outside the body (external-beam radiation therapy), or it may come from radioactive material placed in the body near cancer cells (internal radiation therapy, also called brachytherapy). Systemic radiation therapy uses radioactive substances, such as radioactive iodine, that travel in the blood to kill cancer cells (Goldenberg, 2008).

Chemotherapy

Chemotherapy is the use of drugs to kill cancer cells, usually by stopping the cancer cellsô ability to grow and divide. Systemic chemotherapy is delivered through the bloodstream to reach cancer cells throughout the body. A chemotherapy regimen (schedule) usually consists of a specific number of cycles given over a set period of time. A patient may receive one drug at a time or combinations of different drugs at the same time (Joensuu, 2008).

Targeted therapy

Targeted therapy is a treatment that targets the cancer-specific genes, proteins, or the tissue environment that contributes to cancer growth and survival. This type of treatment blocks the growth and spread of cancer cells while limiting damage to normal cells, usually leading to fewer side effects than other cancer medications.

Immunotherapy

Immunotherapy (also called biologic therapy) is designed to boost the body's natural defenses to fight the cancer. It uses materials made either by the body or in a laboratory to bolster, target, or restore immune system function (Waldmann, 2003).

Hormonal therapy

Several types of cancer, including some breast cancers and prostate cancers only grow and spread in the presence of natural chemicals in the body called hormones. Hormonal therapy treats cancer by lowering the amounts of hormones in the body. It is usually used to treat cancers of the prostate, breast, thyroid, and reproductive system (Sprague *et al.,* 2011).

Stem cell/bone marrow transplantation

A stem cell transplant is a medical procedure in which diseased bone marrow is replaced by highly specialized cells, called hematopoietic stem cells. Hematopoietic stem cells are found both in the bloodstream and in the bone marrow. Today, this procedure is more commonly called a stem cell transplant, rather than bone marrow transplant, because it is the blood stem cells that are typically being transplanted, not the actual bone marrow tissue (Adamo *et al.,* 2010).

Although cancer epidemiological studies including causes of cancer, population estimates, dietary factors, environment factors and treatment options have been extensively conducted by the western scientific world, the contribution of Asian countries has also been significant. Moreover, the continuous contribution of India in cancer epidemiological studies cannot be denied or underestimated. On a national level, a proper networking with each and every state is being developed to understand cancer trends and possible prevention methods.

In order to gain insights into the extent of cancer problem, a cancer survey was undertaken in the Mainpuri district of Uttar Pradesh near Agra for limited period in 1963. In the same year, a population based cancer registry was established in Mumbai to register all cancer patients in the entire population of the metropolis (Jussawala and Deshpande, 1996). To study the cancer problem in depth throughout the state of Maharashtra, three satellite registries of

Bombay registry were established. The first satellite registry was established in Pune city in 1972 (Jussawala and Jain, 1979), the second at Aurangabad in 1978 (Jussawala *et al*., 1984) and the third at Nagpur in 1980 (Jussawala *et al.,* 1985). In 1980, a population based cancer registry was established for Ahmedabad city in Gujarat by Gujarat cancer research institute (GCRI) (Patel, 1986).

The present investigation however, is an effort to unveil such epidemiological approaches regarding cancer in Gujarat. The emphasis has been laid on epidemiology, surveillance, diagnosis and treatment schedule in the urban, suburban and rural areas of Ahmedabad. An effort has been made to statistically validate information gathered from population based cancer registry, hospital based cancer registry as well as from rural cancer registry under national cancer registry program (NCRP), which was a one time dream of the Indian Council of Medical Research. It was thought pertinent to develop Cancer Stat Fact Sheets by collecting and analyzing information from various pharmaceuticals and hospitals across Ahmedabad. The present survey was aimed at drawing insights such as to have a valid estimate of annual incidence of cancer; to study cancer patterns of annual incidence of cancer cases; to study cancer related mortality through death records from the Municipal Corporation and Municipality offices; to study the relation between the cancer incidence and lifestyle, behavior and environmental factors and to provide a fact sheet sighting the best treatment options.

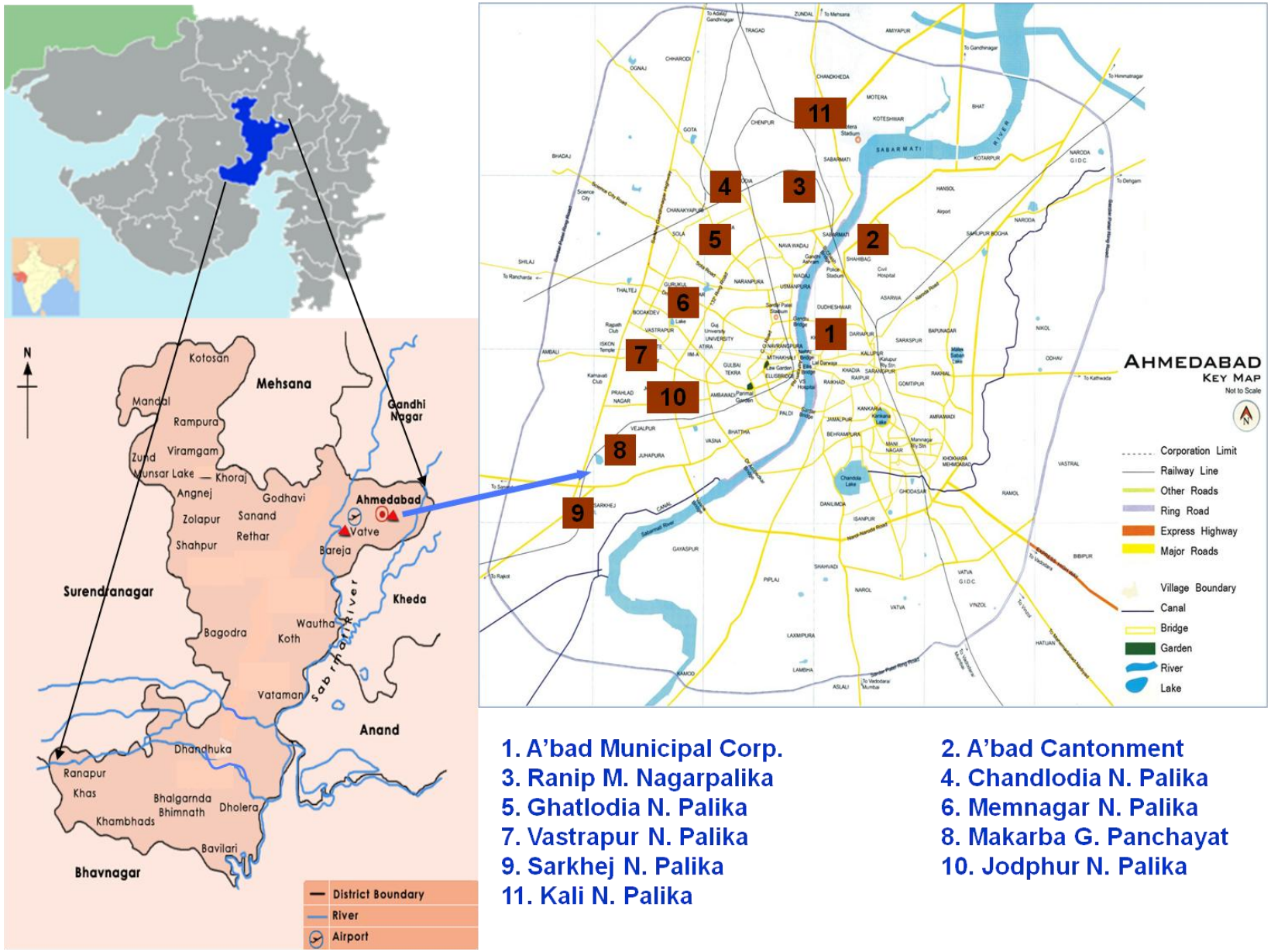
MATERIAL AND METHODS

STUDY DESIGN

Gujarat is one of the promising states of India with regard to industrial set up. In the present investigation a systematic effort to unveil the trends of the dreaded disease Cancer in Ahmedabad district of Gujarat over a period of three years, 2008-2010 has been carried out. The emphasis has been laid on epidemiology, surveillance, diagnosis and treatment schedule in Ahmedabad urban, suburban and rural areas. Ahmedabad is administered by the Ahmedabad Municipal Corporation (AMC). Some of the regions surrounding the city are administered by the Ahmedabad Urban Development Authority (AUDA) which was established on February 1st, 1978 by the Gujarat State Government and its prime objective was to carry out a well-planned and sustained development of the area falling outside the periphery of Ahmedabad Municipal Corporation. However, Ahmedabad Urban Agglomeration Area which is administered by AUDA is not included in present study.

The study area covered under the present survey included:

- Ahmedabad Municipal Corporation
- Ahmedabad Cantonment
- Ranip Mahanagar Palika
- Chandlodia Nagar Palika
- Ghatlodia Nagar Palika
- Memnagar Nagar Palika
- Vastrapur Nagar Palika
- Makarba Gram Panchayat
- Sarkhej Nagar Palika
- Kali Nagar Palika
- Jodhpur Nagar Palika



Map depicting the sources of data collection

The following details were recorded during the present study

- Percentage of population and cancer cases by broad age-group and gender
- Year wise distribution of cancer incidence
- Socio-demographic details
- Methods of diagnosis used in hospitals *viz*. microscopic verification, radiology, imaging techniques, clinical and biochemical tests or endoscopy. The microscopic verification included histological examination of the material from the primary site, from metastatic site, cytological diagnosis as well as haematological examination.
- Leading sites of cancer
- Methods of treatment and their effects- surgical, radiation therapy, chemotherapy (Alkylating agents, Antimetabolites, enzymes, hormones, etc.), target therapy (monoclonal antibodies).
- Number of solid tumour patients and treatment
- Number of haematological malignancy patients and treatment
- Number of protocols used in different indication
- Bone marrow transplant (various places)
- Age-specific cancer mortality rates

These informations were collected using a questionnaire and a format for the same is given in the end as Annexure II.

SOURCES OF REGISTRATION AND DATA COLLECTION

Rural Cancer Registry-Ahmedabad District (RCR-AD) was the main source of information for this study. The permission letter for the use of the data is obtained and appended at the

end as Annexure I. However, during the tenure of the study (2008-2010) we referred to and analysed only 21619 cases which remain as our sample population.

RCR-AD was started at Gujarat Cancer and Research Institute (GCRI), Ahmedabad under network project of National Cancer Registry Programme of Indian Council of Medical Research (ICMR) from 1st January 2004. GCRI is a Regional Cancer Centre, the only comprehensive centre for cancer treatment in Gujarat. Main objective of RCR-AD is to assess the magnitude and type of various cancers in the rural areas of Ahmedabad district and to provide a framework for assessing the impact of cancer on the community.

RCR-AD covers more than 275 sources. There are 60 collaborating hospitals (Municipal hospitals, Government hospitals, corporate hospitals and Trust hospitals). The Birth & Death department of Ahmedabad Municipal Corporation, Jilla Panchayat, Nagar palikas and wards were also important sources of information. Trained field investigators filled the core Proforma by direct interview with patient/relative at time of registration in GCRI. The inclusion criterion for registration of cases was that patients must be residents of the defined areas of Urban Ahmedabad for a minimum period of one year at the time of first diagnosis of cancer.

The following information was extracted out from the cancer patients by the registry team

- Name of patient
- Age
- Sex
- Address
- Type of cancer and stage
- Any addiction (Pan-masala, smoking, alcohol, others)
- Any person in family known to suffer from cancer
- Symptoms

- Diagnosis type
- Treatment type

The ICDO (International Classification of Diseases for Oncology) morphology describes histology and behaviour of cancer cells as separate variables. In ICDO, morphology is a 4-digit number ranging from 8000 to 9989, and behaviour is a single digit which can be 0, 1, 2, 3, 6 or 9. This is followed by the grade, differentiation, or phenotype code (a single digit) which provides supplementary information about the tumour. The behaviour of a tumour is the way it acts within the body. A tumour can grow in place without the potential for spread (0, benign); it can be malignant but still growing in place (2, non invasive or *in situ*); it can invade surrounding tissues (3, malignant, primary site); it can disseminate from its point of origin and begin to grow at another site (6, metastatic); or it can be metastatic but whether primary or metastatic site is uncertain (9).

The International Statistical Classification of Diseases and Related Health Problems (commonly referred to as ICD) is an extensive list of (alpha-numeric) codes used since 1900 to classify diseases and conditions and a wide variety of signs, symptoms, abnormal findings, complaints, social circumstances and external causes of injury or disease. The ICD is published by the World Health Organization (WHO). The ICD is used worldwide for morbidity and mortality statistics, reimbursement systems, and automated decision support in medicine. The United States is required to use the ICD for the classification of diseases and injuries that are reported on the death certificate under an agreement with WHO. By using the ICD, the U.S. and all vital records registration areas collect, process, and disseminate coded mortality data in a similar way to other countries around the world. This permits comparison of mortality (cause of death) data across and within countries. Periodically, new revisions are developed to reflect advances in medical science (ICDO, 1990).

The latest version or ICD-10 (10th revision, 1992), as it is commonly known, was first used in 1999 to codify and report information from death certificates in the United States. ICD codes are assigned to all causes and conditions reported by the certifying physician, medical examiner or coroner on the death certificate. That information is then used to determine the underlying cause of death to report aggregate and comparable mortality statistics (ICD-10, 2010).

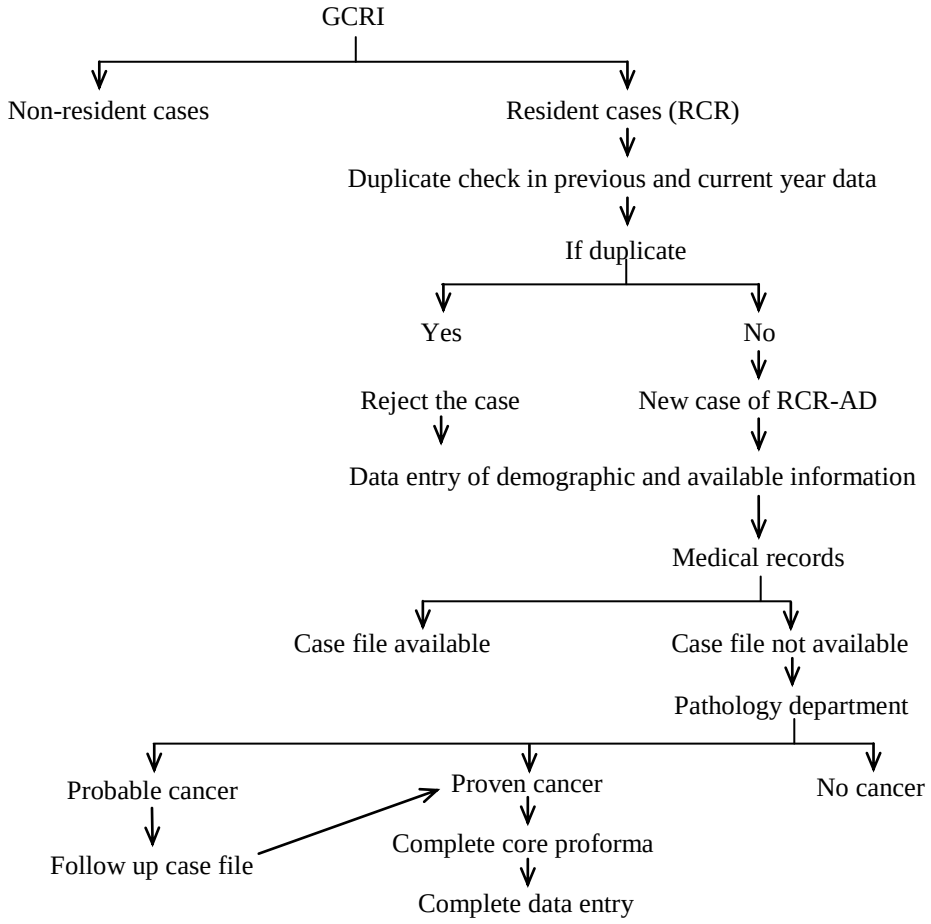
Given below is a list of the ICD coding (C00-D48) which is used for neoplasms and is been followed in the current study for the purpose of analysis.

ICD-10	**Label**
C00	Lip
C00-14	Lip, oral cavity and pharynx
C01-02	Tongue
C03-06+C46.2	Mouth
C07-08	Salivary glands
C09-14	Pharynx
C15	Oesophagus
C16	Stomach
C17	Small intestine
C18	Colon
C18-21	Colorectal
C19-21	Rectum and anus
C22	Liver
C23-24	Gallbladder
C25	Pancreas
C30-31	Nose, sinuses
C32	Larynx
C33-34	Lung
C38.4+sC45.0	Pleura
C40-41	Bone
C43	Melanoma of skin
C44+C46.0	Skin, non-melanoma
C49+C46.1	Soft tissues

ICD-10	**Label**
C50	Breast
C51-52,C57.7-9	Other female genital organs
C53	Cervix uteri
C54	Corpus uteri
C55+C58	Uterus, other
C56,C57.0-4	Ovary etc.
C60+C63	Penis etc.
C61	Prostate
C62	Testis
C64	Kidney
C65-68+D09.0+D41.4	Bladder etc.
C69	Eye
C70-72+D32-33+D42-43	Brain, central nervous system
C73	Thyroid
C74	Adrenal
C81	Hodgkin lymphoma
C82-85,C96	Non-Hodgkin lymphoma
C90	Multiple myeloma
C91-95	Leukaemia
C91-95\C9X.0	Other leukaemia
C91.0+C92.0+C93.0+C94.0+C95.0	Acute leukaemia
CXX.X\(C44+C46.0)+D09.0+D41.4+D32-33+D42-43	All sites but non-melanoma skin cancer

In the current study, only invasive cancers (5^{th} digit morphology code 3 or 6) were reported. Benign tumors and *in situ* cancers were not included for analysis. In the first stage, investigators collected socio-demographic details and other necessary information from the patients. Later, the case records of these patients obtained to the registry were also examined to extract information on clinical items such as method of diagnosis, site of cancer, treatment details etc. Working of registry at GCRI was presented in the form of a flowchart as follows:

Working of Registry at Gujarat Cancer Research Institute:

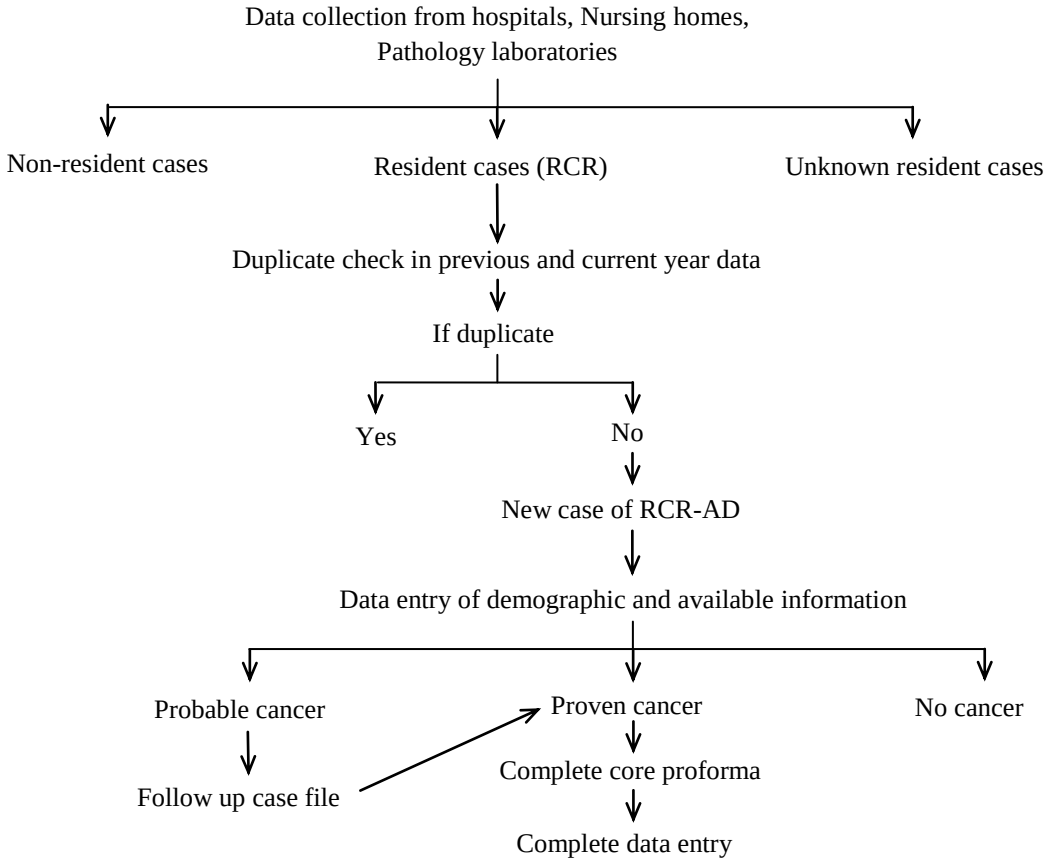


The registry staff also visited various sources of registration in coverage area including all government hospitals, private hospitals, nursing homes and diagnostic laboratories besides the base institution (GCRI) and death registration units in defined area and actively pursued and collected information on the cancer cases reported. At these places, all proven cancer patients and also those under investigation were interviewed regularly. The record files maintained by the various departments of these hospitals *viz*. pathology, hematology, radiology and the various specialized surgical and medical wards were also examined.

The requisite details obtained for each patient, were cross-checked with the information collected from the various departments of the collaborating hospitals, to ensure

completeness of records. Complete information about every cancer patient registered at each and every hospital was thus obtained irrespective of whether or not the patient was subsequently treated at the particular hospital. Additional information was obtained every time a cancer patient was re-admitted or re-examined at a particular institution.

As a result of such data collection from different hospitals, sometimes a single patient was found to be registered at two or more hospitals and thus care was taken to see that multiple entries for the same patients were not made in our records. On the other hand, in some instances, complete medical information about a single patient could be obtained only by combining the data obtained from two or more hospitals. Working of registry at places other than GCRI sources is presented as flowchart as follows:



Working of registry at places other than GCRI sources

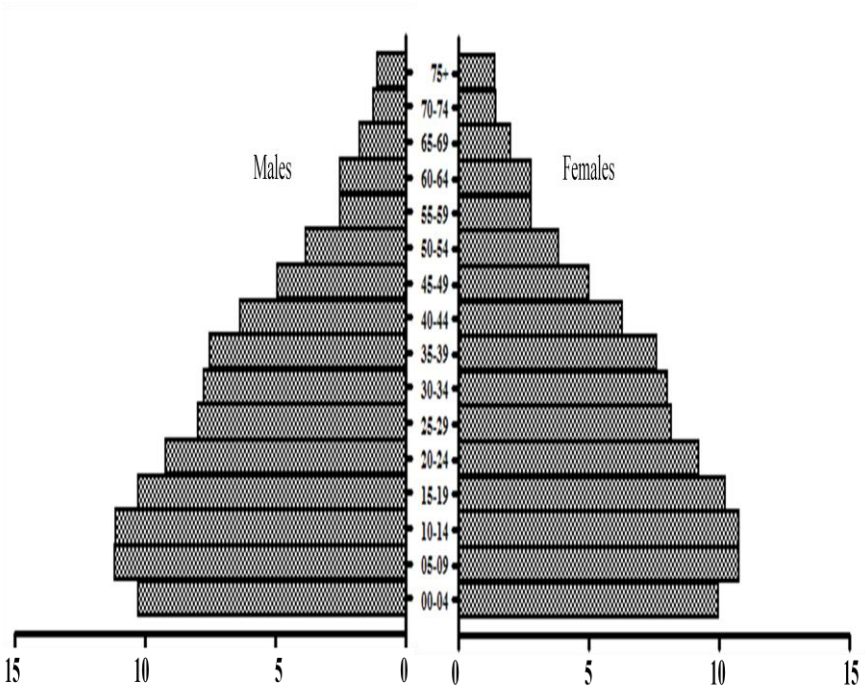
COLLECTION OF MORTALITY DATA

For collection of mortality data help was taken from Ahmedabad Municipal Corporation and Jilla Panchayat along with GCRI and all other sources. Supplementary information about patients could often be obtained from the death records maintained by the Vital Statistics Division of Ahmedabad Municipal Corporation and Jilla Panchayat. Every cancer death not traceable or not matched with registered cases in our files, for the two years of study or for previous years, was labeled as an 'unmatched death' and the date of death was then taken as the date of first diagnosis, and was so registered in the corresponding year's data file as Death Certificate Only (DCO) cases.

The known resident cases as well as those whose residence was not known; both were recorded in our files after collecting necessary information from the various collaborating institutes. Non-residence cases were not considered at all.

POPULATION ESTIMATES

In cancer epidemiology, the following five yearly age groups are usually considered to calculate the various age specific rates : 0-4; 5-9; 10-14; 15-19; 20-24; 25-29; 30-34; 35-39; 40-44; 45-49; 50-54; 55-59; 60-64; 65-69; 70-74; 75 and above. These age groups are referred by i, for example i= 1 refers to 0-4 years age group, similarly i=16 refers to 75years and above age group.



The population estimates for the year 2008 and 2010 as on 1st July (Midpoint of the each year) were obtained by using difference distribution method provided by NCRP (National Cancer Registry Programme) for each group and gender. Population Pyramid presents the percentage distribution of 2008 and 2010 population by age and gender.

Incident cases:

All new cases of cancer diagnosed in a defined population during a specified period of time are considered as incident cases. Hence all new cases of cancer diagnosed in the defined area of Ahemdabad Rural District during the years 2008 and 2010 (1st Jan 2008 to 31st Dec 2010) formed the incident cases.

Incidence Rates:

In general, a rate is defined as frequency of a disease or characteristic, per unit size of population or group in which it is observed. Rates for cancer are always expressed per 100,000. The commonly measured types of rates in cancer were Crude Incidence Rate

(CIR), Age specific Incidence Rate (ASpR), Age-adjusted or Standardized Incidence Rate (A"AR/ ASR) and Truncated Incidence Rate (TR).

Crude Incidence Rate (CIR):

The CIR was calculated by dividing total number of new cases (C) registered during a year by corresponding population of that year (N) and multiplying the result by 100,000.

$$CIR = \frac{C}{N} \times 100{,}000$$

Age Specific Rate (ASpR):

This rate was calculated by dividing number of cases of a given age-group (C_i) by corresponding population of same age group (N_i) and multiplying result by 100,000.

$$ASpR = \frac{C_i}{N_i} \times 100{,}000$$

Age Adjusted/Standardized Rate (AAR):

One of the most frequently encountered problems in cancer epidemiology is comparison of incidence rates for a particular cancer between two different populations, or for same population over time. If one population is, on an average, younger than other, then even if age-specific rates were same in both populations, more cases would appear in older population than in younger. Hence, in order to make rates of cancer comparable between two populations or countries a world standard population (given below) that takes into account such disparities was used to arrive at age adjusted or age standardized rates (AAR). This is calculated according to the direct method (Boyle and Parkin, 1991) by obtaining the age specific rates and applying these rates to the standard population in that age group. The world standard population approximates the proportional age distribution of the world and is given below.

Age Group	World Standard Population
0-4	12,000
5-9	10,000
10-14	9,000
15-19	9,000
20-24	8,000
25-29	8,000
30-34	6,000
35-39	6,000
40-44	6,000
45-49	6,000
50-54	5,000
55-59	4,000
60-64	4,000
65-69	3,000
70-74	2,000
75+	2,000
All ages	**100,000**

$$AAR = \frac{\sum_{i=1}^{n} a_i W_i}{\sum_{i=1}^{n} W_i}$$

where a_i is the age specific rate in age class i; W_i is the world standard population in age class i; n is the number of age class interval.

Truncated Rate (TR):

Truncated Rate (TR) is the rate similar to AAR except that it was calculated for the truncated age group of 35-64 years of age.

Cancer mortality rate

For the whole of two consecutive years, the deaths in male and female cancer patients registered were analyzed. The mortality data was also checked for matching with the morbidity data (relative incidence of the disease) of the previous years. Unmatched data was considered as death. The following data was calculated from the so obtained.

- Crude mortality rate (CMR)
- Age-adjusted mortality rate (AAMR)
- Truncated mortality rate by gender (TMR)
- Mortality to Incidence ratio (M/I)

Thus, comprehensively, cancer surveillance at urban and rural Ahmedabad was done incorporating cancer epidemiological statistics, diagnostic tools and treatment schedules besides mortality rate by specific cancer causes.

STATISTICAL ANALYSIS

The data of the present survey were processed and analyzed to give group means and standard error with significance. All the parameters characterized by continuous data were subjected to relevant statistical methods using either GraphPad Prism version 5, GraphPad Software, San Diego California USA (Motulsky, 1999) or IBM SPSS Statistics 19.0.0.

METHODOLOGY FOR DIAGNOSTIC TOOLS OF CANCER CASES IN AHMEDABAD

Information regarding the type of diagnostic methods used was also collected. A brief idea of the diagnostic methods generally being used for detection of cancer has been described in the introduction. Apart from these diagnostic methods, cases were also registered from the death registers of competent authorities as their incidence during lifetime could not be from any other sources.

STAGING: Staging of cancer is important as it helps to plan the appropriate treatment, to identify clinical trials that may be suitable for a particular patient and helps health care providers and researchers exchange information about patients, and also gives them a common terminology for evaluating the results of clinical trials and comparing the results of different trials. Besides, staging was important for the inclusion of cases in the registry as benign tumours were not included in the study.

A careful and systematic attempt to observe the spread of cancer was made by a series of examinations *viz.* ultrasound, X-rays, biopsies and blood tests. Staging included:

Stage I- Early localized cancers which were not metastasized.

Stage II- Cancer spread in two tissues near the original cancer but not beyond this original location

Stage III- Cancer spread to lymph nodes

Stage IV- Distant cancer metastasized to other parts of body.

TNM system

The TNM system is one of the most widely used staging systems. Most medical facilities use it as their main method for cancer reporting. It is based on features of tumour, lymph nodes and metastasis that were each given a number specifying the cancer stage. As per TNM system measurement of tumour was done in three ways-

- Size of primary tumour = T
- Absence/presence of cancer in lymph node= N
- Absence/presence of cancer in other parts of body= M

Where,

N- classified as the amount of regional lymph node involvement from N_0 to N_4

N_0- lymph node involvement

N_4- Extensive involvement

M_0- No metastasis

M_1- Metastasis

METHODOLOGY FOR CANCER TREATMENT

Information regarding treatment type was also collected. Once the cancer is diagnosed, the choice of treatment depended on the length of cancer, location in the body, its spread inside body, age of the patient and general health. The techniques commonly used have been described in the previous chapter.

RESULTS AND DISCUSSION

SOURCES OF REGISTRATION

The National Cancer Registry Programme (NCRP) was commenced by the Indian Council of Medical Research (ICMR) with a network of cancer registries across the country in December 1981. This is the main registry of India which is aimed at collecting the epidemiological data on cancer from all parts of the country, analysing the aetiology of cancer and comparing the information thus generated with similar data, if any, from other countries. There are seven such registries spread across the country that collect data from its own as well as from the neighbouring states. Gujarat Cancer and Research Institute (GCRI) of Ahmedabad is one of them. During the study period of 2008 to 2010, 15,837 (73.5%) incident cases were registered from GCRI and 5,722 (26.5%) were registered from other sources in Ahmedabad. Other sources can mainly be divided into three groups: Sources of Ahmedabad urban Area, Source of Ahmedabad District (other than Urban Area i.e. rural area) and Sources outside Ahmedabad District. Distribution of incident cases by various sources is shown in Table 1.

After cross-checking the data collected and removing duplicate cases, 15,837 (73.5%) cases were found to be registered from GCRI, 4,858 (22.5%) cases were from Urban Sources and 202 (0.9%) cases were registered from sources outside Ahmedabad (Figure 1).

MAGNITUDE OF CANCER

Total number of cancer cases (malignant and non-malignant) registered at the institute as well as absolute number of cancer cases are found increasing year after year over the last two decades. The age-wise distribution of total cases for each sex during 2005 to 2007 and 2008

to 2010 is shown in Table 2 and Table 3. It has been observed that during early seventies the proportion of men reporting to the institute was nearly 70% as against to 30% of women (The M:F sex ratio was 1.1:1 in 1972). The population of women patients gradually increased and by the late eighties, nearly 40% of the cases registered were of women. The male to female cancer case ratio for the year 2005 to 2007 was 1.65:1, whereas during the study period of 2008 to 2010, male to female ratio observed was in the range of 1.49 to 1. During the study period of three years there was observed a slight but definite increase in the rate of cancer incidence and which, however, was found steady for the age group of 30 to 34 years.

U.S. Bureau in the year 1953 had reported a similar increase in the number of cancer cases and reasoned it to the rising population size as well as the increase in the proportion of elderly people in the population compared to the earlier years. This assumption holds true for India too since there is isolated report of a similar composition in the demography with increased proportion of elderly persons in the population due to improved health care and quality of life (Murthy *et al.,* 1990).

The present study report indicates increased percentage incidence of male cancer cases in different class intervals (interval width of 5) of age groups between 2005-2007 and 2008-2010 (Figure 2 and 4). However, the age groups of 45-49 and 60-64 years showed only marginal increase in percentage of cancer amongst male during the three years of investigation period compared to the earlier period ((Figure 2 and 4). The frequency distribution of cancer cases in females for the years 2005-2007 and 2008-2010 is depicted in figure 3 and 5. It is well known that lifestyles, age composition of the population and total population size are determinants of cancer magnitude (Chen and Habibul, 2004; Murthy *et al.*, 2011). In addition to age, there is enough evidence to show that risk factors such as tobacco use (smoking or chewing), unhealthy dietary habits, physical inactivity, alcohol use, infections and also behavioural alteration might play significant roles in increasing the

magnitude of cancer cases (Murthy and Mathew, 2004). The above explanations also hold true for the present observation of hike in cancer cases in almost all class intervals of age group between 2005-2007 and 2008-2010.

GENDER SPECIFIC PERCENT INCIDENCE

During the three years of study period, the percent incidence of cancer is increased by over 100% in both the sexes (Table 4; Figure 6), as can be observed from the number of registered cases in 2010 for both male as well as female. Moreover, the percentage of female registration was only marginally less as compared to that of males during the three years of the study (Table-4).

The results of the studies by Divan (2003) and Glorian *et al.* (2005) indicate that males are more likely to be involved in various types of occupations and hence face a greater possibility of exposure to various risk factors than females. In addition to this, males are more likely, as compared to females, to be addicted to consumption of alcohol, tobacco, pan masala etc., which are important factors for increase in cancer susceptibility. Many observations indicate that women have a much longer life expectancy than men (Blatt Kalben, 2002). Some population-based studies on cancer patients support the idea of the role of gender in predicting survival. However, contradicting results are also found. For instance, a recent report has highlighted that 1 in 10 men and 1 in 8 women would develop cancer of any form some time after the age of 35 years (Murthy *et al.*, 2011).

PROPORTION OF CANCERS BY AGE GROUPS

When proportion (%) of cancers were classified according to four different broad age groups of 0-14, 15-34, 35-64, 65+ years, 4.71% of cases were found reported in the paediatric age-group of 0-14 years, 12.75% in 15-34 years, 64.36% in the truncated age group of 35-64 years and 18.19% in the older age group (Table-5). In other words, over 82% of the cancer cases were reported from individuals above 35 years of age. The total population above the

age of 35 years accounted for about 34% in both sexes, thus indicating the need for control and awareness measures to prevent cancer problem among the general population at the very beginning of truncated age group (35-64). The observed distribution of population and incident cancer cases by broad age group for males indicates that the age group of 65+ is more affected by cancer (Figure -7), but in the case of females the risk is less severe in comparison to that of males (Figure -8).

The data in Table 6 shows that the total annual age-adjusted rate (AAR) for males is 107.9. The total crude age-specific rate (CAR) is 74.5 and total truncated age-specific rate (TAR) is 187.4. For cancers of the oral cavity (C1-C6), AAR is 23.5, CAR is 19.8, and TAR is 57.7, which is the highest among all the cancers found in the male population. Cancer of the adrenal gland (C74) shows the lowest AAR (0), CAR (0) TAR (0.1). For females, the total AAR, CAR and TAR values are 84.31, 74.38 and 161.92 respectively (Table 7). For breast cancer (C50), AAR is 24.9, CAR is 24.0 and TR is 56.3, which is the highest among all the cancers found in the female population. Closely second to that is cervical cancer (C53), which shows AAR as 10.3, CRAR as 8.6, and TR as 22.8.

Further, the proportion of cancer cases has been grouped into 16 different age classes of 0-04, 05-09, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74 and 75+years for an age-specific investigation (Table 8). The age specific incidence rates ranged between 5.3 (0-4 years age group) and 350.74 (75+ years age group) per 100,000 persons for males and 3.43 (5-9 years age group) to 154.45 (65-69 years age group) per 100,000 persons for females.

The age-specific incidence of cancer cases is shown in figure 9. The incidence rate among children under 05 years of age is higher (7.81) than in children of ages 05 to 09 years in females. But in case of males, the incidence is higher in the age group of 05 to 09 years (Table 8).

Cutler and Haenszel in 1954, from their analysis on the incidence of cancer across various age groups, have emphasized on an increase in cancer illness with advancing age and opined this as a usually observed trend. This is apparent in the present analysis too. The cancer incidence rate, however, continues to increase and reaches the summit in an advanced age compared to the younger age groups, which is possibly the trend all over the world. According to a United States cancer study, considering the number of diagnosed cases with respect to population proportion in each group, the annual cancer incidence rate was reported to be 37.8 per 100,000 persons for the age group of 35-39 years as compared to a rate of 346 per 100,000 persons for age group of 75 and above (Pollack, 2003). The results of the current study also showed a similar rate of cancer incidence for persons of 35-39 and 75+ years of age. As a general rule, cancer screening for people of the age group of 30-50 years would be a positive step in creating cancer awareness, prevention and control. However, the rate of cancer incidence is relatively low in this age group. Consequently, the proportion and type of cancer cases found in the screened population would be low. Cancer screening amongst old age people, 60 years of age and older would produce a high proportion of positives since the cancer incidence rate is higher among older people as has been opined by Cutler and Haenszel (1954), but this approach ignores the desirability of salvaging productive year of life and it would also produce a small number of cases since the number of old people in the population is relatively small. Hence a holistic approach of screening in all the age classes, though sounds impractical, would only suffice this problem.

LEADING SITES OF CANCER

The first ten leading sites of cancers among males and females are shown in Table 9; Figures 10 & 11. Ranking of these sites are based on the frequency of their occurrence in the population of study area for the three years of study (2008-2010). Among males, the mouth is the most predominant site of cancer constituting 24.03% of the total cancers followed by cancer of tongue (10.87%), lung (5.69%), oesophagus (5.21%) and hypopharynx (5.2%).

Among females cancer of breast is predominant and has accounted for 30.37% of the total cancers followed by cancer of cervix (12.67%), ovary (8.8%), oesophagus (4.45%) and mouth (3.51%).

Altogether, the ten leading sites of cancer among males and females accounted for 66.93% of the total cancers in males and about 74.78% of the total cancers in females. Among these 10 leading sites of cancer, the first five leading sites of cancers of males and females are shown in Table 10; Figures 12 & 13. Ranking of these sites are based on the frequency of their occurrence. Among males, cancer of the mouth (24.03%) is the most predominant site of cancer but in female the cancer of mouth (3.51%), has accounted as a low percent incidence rate and ranked only fifth among the major sites. Altogether, the first five leading sites of cancers among males and females accounted for 46.01% of the total cancers in males and about 49.27% of the total cancers in females.

Oesophageal cancer is found to have an increased incidence in both males and females and its incidence is currently higher as compared to the cases registered with GCRI during the late nineties (1.9%). Such observation of an increasing trend in oesophageal cancer is not noticed in the younger age group of males at 0-10 years. The aetiology of oesophageal cancer could be the consumption of tobacco (smoking or smokeless) and alcohol. In addition, Barrett's oesophagus, diet & nutrition as well as reflux disease also play an important role in the initiation of oesophageal cancer (Blot *et al*., 1995; Enzinger and Mayer, 2003). However, a wholesome picture about the prevalence of smoking/tobacco/alcohol in all states of India is still vague. Because of lack of such data we cannot correlate our findings with the prevalence of smoking among the Indian population. Nevertheless, considering the rise of oesophageal cancer in Indian population females, data regarding histological subtype evaluation of this cancer should be collected to comprehend the mechanism of its development and treatment.

Our present study results also showed a high percent incidence (3.2%) of colon cancer and it is one of the first ten leading cancers in males among the cases registered at Ahmedabad GCRI. Slattery (2000), from the analysis of general population, deduced that 13% of colorectal cancer is a result of being physically inactive, 12% cases have been attributed to eating a Western style diet, and 8% to having a first degree relative with colorectal cancer. The diet of Indians has changed from one featuring low-fat, high-fibre foods to one characterized by higher-fat animal protein, low fibre, and high levels of saturated fat. Nowadays there is also an increased tendency among Indians to consume fast foods and convenience foods (Kulkarni, 2004). The significantly rising trend of colon cancers seen even in females, which is otherwise a low-risk population, may be related to subsequent acculturation and adoption of a Western diet and lifestyle (Kulkarni, 2004). Both males and females of the present time experienced more than four-fold risk of developing colorectal cancer compared to the early twentieth century (Kulkarni, 2004).

As compared to females, the males of the Indian population are at higher risk for bronchus and lung cancer. The five-fold risk in males as compared to the females and an increasing trend over the years is noteworthy (GCRI Annual Report, 2007). Lung cancer is one of the ten leading cancers among males reported from Ahmedabad. This prevalence could be attributed to the fact that males are subjected to a greater risk of exposure to the carcinogenic agents in the form of occupational hazards and also to the predominance of smoking habit among males of the population as compared to the females. Lung and bronchus cancer is ranked third among all reported cancer cases for males at Ahmedabad with a 5.69% incidence rate (Table 9). Lung and bronchus cancer incidence is found maximum (34.31%) at the ages of 65 plus and is ranked first among the leading cancers in males of this age group (Table 12; Figure 16). However, in case of females of this age group (65+ years), the reported incidence is only 13.21% and is ranked third among the five leading cancers among old age females (Table 12; Figure 17). Nevertheless, the presently observed trend of less incidence of lung cancer in females compared to that of males is not in accordance with a

decade old study done in the UK population, which reports increase in incidence of lung cancer in both men as well as women (Smith *et al*., 2003).

A high incidence of Non-Hodgking's Lymphomas (NHL) has been observed in the Ahmedabad population of Gujarat during the tenure of the study. An analysis of the obtained data revealed that the percent incidence of NHL is increasing since the last decade in Indian population (Yeole, 2008). Among all the age groups, a high paediatric NHL incidence of 13.84% has been observed and it has been ranked second in male paediatric cancer cases after blood cancer during the current study (Table 11; Figure 14). Even though, the incidence of NHL has doubled even in the U.S., the aetiology of lymphoma remains elusive. Epidemiological studies suggest the role of hereditary factors, immunosuppression, viruses (HIV, EBV, HTLV, *H. pylori*, HHV8, HCV), exposure to chemicals including agrochemicals and a myriad of other factors as etiological agents of NHL (Fischer and Fischer, 2004). Recent studies have also associated menstrual and reproductive factors (higher parity and early menarche offer a protective effect for NHL) with risk of NHL (Nelson *et al*., 2001; Zhang *et al*., 2004).

Three-fold higher risk of developing leukaemia, in the paediatric cases of Ahmedabad urban population as compared to that of rural areas and an increased incidence of this cancer over the time shows similarity with results from studies in the U.K. (Powell *et al.*, 1994; Cummins *et al*., 2001; McKinney *et al*., 2003). Types of leukaemia and their causes vary widely and are age dependent. Leukemic patients were found more in the paediatric age group of both the sexes. The percent incidence is 66.98% in case of male and the incidence in female is 62.55% among all the paediatric cases in the age group of 0 to 14 years (Table 11). Registered cases from Ahmedabad at GCRI also reveal that incidence of leukaemia is found up to the age of 35 years and after that age this cancer is not a leading cancer (Table 12). The collected data also revealed that the lymphoid leukaemia is the first leading cancer in children (Table 11; Figures14 & 15). However, at the age group of 15 to 34 years the

myeloid leukaemia emerges as the leading cancer among all the recorded cancers of males with a percent incidence of 32.72% and in females it ranked third with 14.3% incidence (Table-10 Figures 16 & 17)). Cancers of brain are infrequent in India and are reported frequent in the U.S. But percent incidence of this cancer is increasing in Indian population (Preston, 1989; Preston and Mack, 1995). Present investigation suggests that the incidence of brain cancer is more frequently encountered in children than in adult. This cancer is recorded with 11.6% incidence in male and 10.49% incidence in female in the age group of 0 to 14 years in Ahmedabad population during the study period.

The hitherto identified causative factors for gallbladder cancer include gallstones and genetic susceptibility. However, liver flukes in Asian countries have also been suggested to be causative agents of gallbladder cancer (Khuroo *et al*., 1989). In one study done in India, the prevalence of gallstones in adult population was reported to be 6.12% (3.07% in males, 3.05% in females) (Fraumeni *et al*., 1995). All these above stated factors could explain our finding of higher incidence (2.46%) of gallbladder cancers in the females of Ahmedabad population (Figure 11). Similar findings have also surfaced from the studies conducted amongst the South African immigrants to the United Kingdom (Barker and Baker, 1990; Swerdlow *et al*., 1995; Winter *et al*., 1999).

GENDER-SPECIFIC CANCERS

Malignancy to prostate is common among males and it has been observed that the incidence of prostate cancer increased during the study period compared to 1988 - 2000 (GCRI Annual Report, 2002). During the three years of this study, prostate cancer was found as one of the ten leading cancers in males with 2.82% incidence among all the cancers observed in Ahmedabad (Table 9). Epidemiological studies suggest that endogenous risk factors like family history, androgens, race, aging, oxidative stress and exogenous factors including diet and environmental agents have been associated with this cancer (Bostwick *et al*., 2004). Other studies suggest that screening for this cancer has dramatically increased in the number

of men with local disease (Brawley *et al*., 1998). Variation in genetic susceptibility or metabolism in high- and low-risk populations too might have contributed to the large disparity in incidence rates (Shibata *et al.*, 1997; Shibata and Whittemore, 1997). It has been suggested that the substantial ethnic differences in prostate cancer risk are due to differences in androgen levels and in the activity of 5-α-reductase (the enzyme that converts testosterone to dihydrotestosterone, the principal nuclear androgen in the prostate) between western and Asian men (Ross *et al.*, 1992, 1995).

Our time-trend analysis suggests that, although *in situ* breast cancer diagnosis has significantly increased in India, invasive breast cancer diagnosis has not gained popularly in India as compared to U.S. or Europe (Harrison *et al.*, 2010). Table 9 indicates that the breast cancer percent incidence (30.37%) comes first among the ten leading cancers among the female cases registered at Ahmedabad. Moreover, the incidence of breast cancer is ranked first among all the leading cancers in females in all the age groups analysed (Table 12). In the general population, major risk factors include late maternal age at first parity (>30 years of age), having one child vs. many, use of oral contraceptives (OCs), use of hormone replacement therapy (HRT), obesity and alcohol consumption (Jussawalla and Jain, 1977; Vatten, 1998; Wenten *et al*., 2002). Due to the polymorphism of the BRCA1 and BRCA2 gene the Caucasian population is less susceptible to breast cancer. However, after the year 2001 the frequency of this cancer is reported increasing (Chatterjee and Mukherjee, 2011), which justifies our present result of increased percent incidence (30.37%) of breast cancer (Table 10). According to the national registry of cancer, the female population of Ahmedabad is ranked third in India for registered cases of breast cancer after Nagpur and Imphal (Saxena *et al.*, 2002; NCRP, 2007). Adoption of modern lifestyle practices by Indian women and inadequate screening could be the two major possible reasons for the observed increase in breast cancer in this population. Breast cancer is cited as the number one cancer among females in some states of U.S. and they are 3.5 times more likely to develop this cancer as compared to their counterparts in India (Singletary and Gapstur, 2001).

HPV (Human papilloma virus) has been proposed as the first identified necessary cause of cervical cancer (Liu *et al*., 1998; Bosch and de Sanjose, 2002) and hence we attribute this virus infestation for the increasing trend of cervical cancer in Indian women too. Cervical cancer is the second leading cancer with 12.67% incidence rate among all the registered cases of cancer in women for the three years study span. This cancer incidence rate is observed to be increasing after the age of 15 years and has been found constant in all the higher age groups of female patients of Ahmedabad (Figure10). Women in Europe and United States are getting screened at very early stages and hence, treated completely as compared to the Indian women (Srivastava *et al.*, 2012) India ranks number one in incidences of Cervical cancer (NCRP, 2009; NHAC, 2009).

In India, during the period 2004-2005, it has been reported that, the proportion of ovarian cancer ranged between 1.7% and 8.7% of all cases of cancer in females registered at Ahmedabad. The distribution of age-specific incidence rates of ovarian cancer from the urban and rural registries of GCRI for the period 2008-2010 in the different age groups is shown in table 12. The analysis of the record also indicates that the disease does not occur at a very young age (Table 11). Incidence rate was observed increasing with age (Table 112). Moreover, it was observed that the incidence rates start increasing from the age of 35 years and reach the peak at 65+ years of age (Figure 17). A comparative assessment of age-specific incidence-rates amongst urban and rural registries of GCRI revealed that the registry areas with lower Age Standardized Rate (ASR) of ovarian cancer showed lower age specific incidence rates and vice versa. The mean age of occurrence of ovarian cancer varied between 52.2 to 59.5 years in the GCRI registries of M.P. Shah Cancer Hospital at Ahmedabad. Current analysis also revealed that the age groups of 15 years and above are more prone to ovarian cancer. In India, cancer of the ovary is one of the most common cancers amongst females and occupied third or fourth rank among cancers occurring in women during the year 2004-05 as cited in various Indian registries like Bangalore, Pune, and Chennai (Murthy

et al., 2009). In general, trends in the incidence of ovarian cancer may occur from a variety of factors such as initiation of screening programme, changes in diagnostic methods, completeness and reliability of data, changing profile of risk factors in the population, or as a consequence of better health awareness (Parkin *et al.*, 2002).

Further scan through the records reveals an increase of 0.31% per annum in the age-standardized incidence rate of ovarian cancer in the observation period 1968-72 to the prediction period of 1998-2002. A small increase due to birth cohort effect has also been reported (Yeole, 1997; Goodman and Howe, 2003). There was recorded a 13.21% incidence of ovarian cancer in this study during 2010 in the age group of 65 and above. A systematic examination of time trends in ovarian cancer risk for most of the major cancers, and for different countries and regions of the world has been studied by Coleman *et al.* (1993). La Vecchia (2001) in a review on epidemiology of ovarian cancer has indicated that cosmetic talc use and some aspect of diet (i.e. saturated fats, refined carbohydrates) may be associated with the increased risk of ovarian cancer. An inverse relationship with vegetable consumption has also been reported (La Vecchia, 2001; Sagae *et al*., 2002).

Uterine/endometrial cancer used to be a disease of the developed world. Epidemiological studies have shown that majority of the incidence could be attributed to excess body weight (in turn due to 'unopposed estrogens'), lack of physical activity, exogenous hormones and chronic hyperinsulinemia along with genetic predisposition (Akhmedkhanov *et al.*, 2001; Kaaks *et al.*, 2002). In 1998-2005, the incidence rate of cancer of the corpus uteri [age standardized rate (ASR)], was highest in Delhi and lowest in Pune and Imphal (4.4 and 0.0 per 100,000 woman-years, respectively). The incidence rate in most of the registries between the two time periods (1983-1998, 1999-2005) showed an increase with few exceptions. Estimation of annual percentage change (EAPC) carried out in Mumbai, Chennai, and Bangalore Population Based Cancer Registries (PBCRs) for the period 1983–2002 showed statistically significant increases in crude rate, ASR, and age-specific incidence rates (ASIR).

The largest EAPC in ASR was in Bangalore (6.4%) and the smallest was in Chennai (1.8%) (Murthy *et al.*, 2011).

Increasing body mass index shows a strong linear relationship with endometrial cancer and some postulate that the incidence of endometrial cancer will rise to twice the 2005 rates by 2015 (Bjorge *et al.*, 2007; Reeves *et al.*, 2007; Renehan *et al.*, 2008; Lindemann *et al.*, 2008, 2010). In the affluent developed world, obesity is unevenly distributed with greater prevalence in the more deprived socioeconomic groups (Friel *et al.*, 2007). The prevalence of obesity in women has been shown to rise steadily and significantly with increasing area deprivation from 20.1% in the least deprived to 33.1% in the most deprived (Public Health Information for Scotland, 2008).

Given that the obesity is a significant main driver for oestrogen-related endometrial cancer incidence, we investigated if a difference in incidence within socioeconomic strata could be shown. Interestingly, we did not find any difference in distribution amongst various strata of the society and this has remained heterogeneous over the 03 years of the study period. Our findings are in agreement with the national data in endometrial cancer and suggest that the relationship between endometrial cancer incidence, obesity, and deprivation is complex (Cooper *et al.*, 2008; Evans *et al.*, 2011).

INCIDENCE OF CHILDHOOD CANCER

The incidence of childhood cancer in most populations in the world ranges from 75 to 150 per million children per year (Stiller and Parkin, 1996). However, the reported age-standardized incidence rate for India ranges from 38 to 124 per million children per year. The highest incidence is reported from Chennai and the lowest from rural Ahmedabad (Arora *et al*., 2010). This suggests that either there is truly a lesser incidence of childhood cancer in some areas of India, or as is more likely, there is under-ascertainment of cases. The reported incidence in urban areas is found higher than that in rural areas (Ahmedabad

district) and is more comparable with the average world incidence. Again, one can speculate that this can wholly or partly be attributed to under-ascertainment of cases and registration in rural areas, but this remains to be confirmed. It is also necessary to investigate if there are factors associated with urban living *viz.* overcrowding, air pollution, and so on, which contribute to a relatively higher incidence of childhood cancers in such areas.

Overall incidence of cancer in childhood is more common among males than in females and the male to female ratio in the most resource-rich countries is around 1.2:1 (Gurney and Bondy, 2006; Stiller, 2007). According to the registry of GCRI at Ahmedabad, the ratio of childhood cancer incidence of males to females during the study period of 2008 to 2010 was found to be 1.3:1 (Table 11). However, some cancers like Eye and Adnexa (retinoblastoma), Wilms' tumour (nephroblastoma), Bone of limb (osteosarcoma) and germ cell tumour actually showed a slight female preponderance (Figure 14 and 15). The reported incidence of childhood cancer among males in India (39-150 per million children per year) is higher than that among females (23-97 per million children per year) in all PBCRs except in North East India, and this gives a male to female ratio that is much higher than what is seen in the developed world. As incidence rates automatically adjust for the sex ratio in the underlying population, there have to be other reasons for this relatively higher incidence of childhood cancer in males seen in India. Gender bias in seeking healthcare, including treatment of cancer, is one possible explanation (Barr *et al*., 2006). The male predominance for most of the individual cancer types in major metros is an ample testimony for this kind of bias (Arora *et al*., 2009). Nevertheless, one has to consider other possibilities too.

Leukaemia is the most common childhood cancer in India with relative proportion varying between 25 and 40% (Arora *et al*., 2009). Sixty to 85% of all leukaemias reported are acute lymphoblastic leukaemia (ALL). This cancer statistic of India is supportive of our result which shows higher percent incidence (66.98% in male children and 62.55% in female children) of leukaemias at Ahmedabad registry of M.P. Shah Cancer Hospital, which is

highest percent incidence among all the paediatric cancer (Table 11). Compared to the developed world, the biology of ALL appears different in India, with a higher proportion of T-Cell ALL (20-50% as compared to 10-20% in the developed world), hypodiploidy and translocations t(1;19), t(9;22), and t(4;11), all of which contribute to a poorer prognosis of this leukaemia (Rajalekshmy *et al*., 1994; Amare *et al*., 1999; Siraj *et al.,* 2003; Magrath *et al*., 2005). It has been proposed that T-Cell ALL predominates in economically disadvantaged areas, but with urbanization, industrialization, and increasing affluence, common ALL peaks in incidence between the age of 2 and 5 years (Ramot and Magrath, 1982).

In the developed world, CNS tumours are the second most common childhood cancer (22-25%) and lymphomas a distant third (10%) (Gurney and Bondy, 2006; Stiller, 2007). In contrast, in India lymphomas often exceed CNS tumours, particularly in males. Not only is the proportion of lymphomas higher in India, but Hodgkin's disease (HD) exceeds non-Hodgkin's lymphoma (NHL), a pattern opposite to that seen in the developed world. This is postulated to be a result of the high incidence of HD in male children in India (incidence rate of 8.2-19.6 per million children, per year, in Bangalore, Chennai, Delhi, Ahmedabad and Mumbai PBCRs compared to 5.7 in USA and 6.4 in Britain) (Gurney and Bondy, 2006; Stiller, 2007).

In the larger urban areas of Bangalore, Chennai, Delhi, and Mumbai, the incidence rate of CNS tumours is 10-20 per million children per year, which is half of that in the developed world (Arora *et al*., 2010). Interestingly, the incidence of CNS tumours in children in the developed world has increased in the last 30-40 years with increasing availability of CT and MRI scanners (Black, 1998). With the rate of incidence of 11.6 and 10.49 respectively, brain cancer is ranked fourth among the reported leading cancers in male and female children of Ahmedabad (Table 9). A relative paucity of neurodiagnostic and neurosurgical facilities, which leads to missed diagnosis in those presenting with headache, seizures, and altered

sensorium, could explain the differences in incidence in India compared to the rest of the world (Arora *et al*., 2009). Neuroblastoma, which is the second most common solid tumor in childhood after CNS tumours, is much less frequently reported in India. Retinoblastoma has an incidence rate of three to five per million children per year and accounts for 2.5 to 4% of all childhood cancers in most developed countries (Arora *et al*., 2010). Barshi, Chennai, and Delhi report a 2-3 fold higher incidence of tumours of the eye (majority of which will be retinoblastoma in children <15 years of age), a finding that has also been previously reported (Tyagi *et al.,* 2006; Swaminathan *et al*., 2008). Our study report revealed more percent incidence (18.35%) of retinoblastoma in female children and it is one of the five leading cancers found in girl patients of GCRI registry of Ahmedabad (Table 11; Figure 15). It has been reported that in North East India, while the incidence of tumours of the eye is not high, the proportion is 6 to 10% of all childhood cancer. The hospital-based cancer registry in Dibrugarh as well as case series from hospitals in North East India confirms their high proportion among childhood cancer of retinoblastoma in female children (Schultz *et al*., 1993; Das *et al.*, 1994; NCRP, 2007).

TOBACCO RELATED CANCERS

As per the standard norms, cancer of the lip, tongue, mouth, pharyngeal cancers (excluding nasopharynx), oesophagus, larynx, lung and urinary bladder were considered as series of cancers related to tobacco use in this report for comparison purpose with the other registries in the country.

The tobacco-related cancers reported by the Population-based Cancer Registries of Bangalore, Barshi (rural), Ahmedabad, Bhopal, Chennai, Delhi and Mumbai constitute 56.4% and 44.9% of cases in males and females, respectively. The top five or six cancers in men are all tobacco-related cancers *viz.* cancers of the lung, oral cavity, larynx, oesophagus and pharynx. In women, the leading cancer sites related to tobacco include cervix, oral cavity, oesophagus and lung (NCRP, 2004).

Global evidence

Statistical analysis of the present finding suggests that tobacco related cancers (TRCs) accounted for 52.5% of all cancers in males and 24.16% of all cancers in females. Among all tobacco related cancer sites in males, cancer of the oral cavity was the most common site (23.54%) followed by cancer of tongue (20.96%) and lung 16.62%). These three sites together constituted >60% of total TRCs. In females, cancer of oral cavity alone accounted for (21.57%) followed by tongue (18.69%) and lung (16.49%). The numbers and proportion of tobacco related cancers by sex are shown in Table 13 and Figures 18 & 19.

The International Agency for Research on Cancer (IARC) monograph states that tobacco smoking is the major cause of lung cancer (all types) and is associated with oral cancer, cancers of the oropharynx and hypopharynx, oesophagus, stomach, liver, pancreas, larynx, nasopharynx, nasal cavity and nasal sinuses, urinary bladder, kidney and cervix, and myeloid leukaemia (IARC, 1987). In addition, exposure to secondhand tobacco smoke has also been conclusively shown to be carcinogenic to the lungs (IARC, 2004).

Case control studies conducted in India on cancer at various sites have shown that both smoking and smokeless tobacco use (including tobacco with lime and *paan* with tobacco) cause elevated risks for intra-oral, oropharyngeal, oesophageal and cervical cancers, and cancer of the penis. They have shown that smoking in India causes elevated risks for cancer of the lungs, hypopharynx, larynx and stomach. The evidence for a causal association of tobacco use in India and cancer at various sites is based on case-control studies for specific anatomical sites (WHO, 2000; USDHHS, 2004).

The relationship between oral cancer and tobacco use, especially through chewing of *paan* (betel quid) with tobacco, has been reported since the early twentieth century and subsequently through a variety of epidemiological and clinical studies (Niblock, 1902; Gupta

et al., 1996). All of the case control studies conducted on tobacco and prevalence of oral cancer in India showed that the risk of oral cancer increases with the use of tobacco in various forms, compared to non-use of tobacco. Smoking increased the risk of oral cancer relative to non-smokers, and chewing of tobacco (or *paan* with tobacco) tended to have a higher risk for oral cancer than smoking (Dikshit and Kanhere, 2000; Gupta *et al*., 2001). The risk of oral cancer for chewers of tobacco (in any form), compared to non-users was high to very high in different studies, with the risk for women being higher than the risk for men. The men in the study had a 6-fold greater risk of oral cancer if they were *paan*/tobacco users than if they were never users (risk adjusted for smoking) (Balaram *et al*., 2002). The women who chewed *paan*, tobacco in a study in Bangalore had a 25-fold higher risk of oral cancer relative to non-users, while men who chewed *paan* or tobacco had a 3.6-fold risk compared to non-chewers. Men who smoked had a 3.5-fold significantly greater risk than non-users of tobacco (Nandakumar *et al*., 1990). It is clear from the above reviews that the scientific evidence of the role of tobacco use in the causation of oral cancer is ample, with tobacco chewing as a particular concern.

A case control study in Delhi reported a 2.6-fold greater risk for developing oesophageal cancer in chewers of tobacco with betel quid, in relation to non-chewers, and a nearly 2-fold greater risk for *beedi* (small hand-rolled cigarette) smokers in a multivariate model (Nayar *et al*., 2000). Another case control study from Bangalore revealed that tobacco chewing gave users a nearly 3-fold higher risk than non-chewers, and *beedi* smoking a 4-fold greater risk than non-smokers in developing cancer (Nandakumar *et al.*, 1996). The risk of cancer in the lower third of the oesophagus for *paan*/tobacco chewers was 6.6-fold greater than for non chewers. *Beedi* smoking in males was a significant risk factor for cancer of all the three segments of the oesophagus, but conferred a 7-fold greater risk for the upper third compared to that of non-smokers (Nandakumar *et al.*, 1996; Znaor *et al.*, 2003). Our studies in Ahmedabad have also shown that *paan*, tobacco chewing and smoking are significant risk factors for cancer of the oesophagus and it ranked fifth among the leading cancers related to

tobacco in both the sexes. The percent incidence of oesophageal cancer in males and females is higher among the cancers which are triggered by the tobacco chewing and smoking, which increase the risk of developing oesophageal cancer several-fold (Dikshit *et al*., 2012).

METHODS OF DIAGNOSIS

Cancer diagnosis is made by different methods *viz*. microscopic verification, radiology and imaging techniques, clinically, biochemical tests or by endoscopy. However, a small proportion of cases (1.32%) were registered from the death registers of competent authorities as their incidence during life time could not be traced from metastatic site.

During the study period of three years, 95.58% of the cases among males and 96.85% of the cases among females that were recorded were confirmed microscopically. Histology of primary tissue was recorded in 76.09% of all cases, followed by bone marrow (9.27%), secondary histology (5.93%) and in 4.97% of cases the diagnosis was arrived at based on cytology (Figure 20-22). In 1.11% of the cases, the diagnosis of cancer was based on radiology examination only. The death certificate only (DCOs) accounted for 1.32% of the total cancer cases. The number and percentage of cancer cases by method of diagnosis are shown in Table 14.

Investigation by Sen *et al*. (2002) in Kolkata reported similar pattern of cancer diagnosis wherein of the total cases, they analyzed that 79.7% were diagnosed on the basis of microscopic verification by histology or cytology; 21.6% of cases were registered on the basis of information from DCOs; and 3.7% were diagnosed on the basis of clinical, biochemical, endoscopic or radiologic examination findings.

Cancer diagnosis based on standard histological methods is widely described and used in medicine. However, most of the procedures derive from a subjective assessment of observed

changes and in some cases they may be inconclusive (Waloszczyk *et al*., 2011). Hence, other methods like CT scan, biochemical evaluation, endoscopy, etc. should also be employed for accurate diagnosis (Coombes *et al.,* 2005; Munro *et al*., 2006; Palmblad *et al*., 2009). The combination of spectroscopic methods of high resolution (mass spectroscopy, nuclear magnetic resonance) with advanced statistical methods leads to an increased likelihood of developing new applications for diagnostic purposes (Li *et al*., 2002; Zhang *et al*., 2004). The aim of diagnosis is to distinguish benignity and malignancy or to classify different malignancy levels by making use of extracted features. This step uses statistical analysis of the features and machine learning algorithms to reach a decision (Demir and Yener, 2009). There are also other diagnostic approaches that extract information from biological data at molecular and organ levels. At the molecular level, the information is obtained either from gene expression signatures using microarrays (Ben *et al.,* 2000; Khan *et al.,* 2001; Guyon *et al*., 2002) or from protein biomarkers using mass spectrometers (Adam *et al*., 2001; Ball *et al.,* 2002). At the organ level, screening techniques such as mammography (Tzcheva *et al.,* 2003; Kallergi, 2004) are employed.

The importance of cytologic diagnosis in preneoplastic and neoplastic lesions of the cervix has its origins in the years 1927-1928 (Babes, 1928), when two studies were published on the appearance of tumor cells present in cervical and vaginal smears, the names of two researchers giving the name-test currently used for screening and monitoring of these lesions posttherapeutic: The Babes-Papanicolau test.

In our study the preneoplastic and neoplastic lesions identified by cytological examination was 5.09% in males and 4.82% in females, which is quite comparable to what has been reported by Klinkhaemer and coworkers in 1988. Moreover, we identified a wide variety of literature data either supportive or otherwise to the present report. Mostafa *et al*. (2000) identified a lower rate of preneoplastic lesions (3.2%) and Lozowski *et al*., (1982) a much higher rate (7.1%). A good diagnostic acuity, it is reported, could be obtained by combining

cytology, colposcopy and histology. Although the ideal would be to have a high concordance in terms of diagnosis between these methods, the available literature often presents variations and one isolated report even predicts that the cytohistological discrepancy may even reach as high as 47% (Adad *et al.*, 1999).

Accuracy of cytological diagnosis in regard to identification of squamous carcinoma could be 100%, this being seen in studies of Lozowski *et al*. (1982) and Klinkhaemer *et al.* (1988). However, Mostafa and others' study (2000) identified a low rate of diagnostic accuracy (68%) and they attributed this to underdiagnosis or errors of interpretation.

Presence of disseminated tumor cells in bone marrow is indicative of systemic disease even in early stage gastric cancer (Jauch *et al*., 1996). They reported that the extent of tumor-cell presence in bone marrow correlates with prognosis in curatively respected patients. Therefore, a positive bone marrow finding may be a selection criterion for adjuvant treatment because of minimal residual tumor load (Jauch *et al*., 1996). The clinical relevance of circulating epithelial cells as a prognostic factor is not supported by the bone marrow aspiration, especially in comparison with tumor cells in the bone marrow. However, this method of detection may be useful to monitor the efficacy of treatment in advanced or metastatic breast cancer (Pierga *et al*., 2004).

An X-ray is one of the oldest forms of medical imaging, and despite all the newer, more sophisticated forms of scanning, it is still one of the most sensitive ways of detecting many problems (Caro *et al.,* 2000). Although diagnostic X-rays provide great benefits, diagnostic X-rays are the largest man-made source of radiation exposure to the general population, contributing about 14% of the total annual exposure worldwide from all sources (de Gonzalez and Darby, 2004).

It is well documented that the X-rays are not painful and, apart from having to remain still for a short while, there is no associated discomfort. The whole process takes about five to ten minutes depending on how many images are to be taken. A full skeletal survey (X-rays of all the bones in the body) takes approximately 45 minutes to complete. There are no side effects to have an X-ray done. An early diagnosis is of immense importance in lung cancer so that the best mode of therapy for potential cure or optimal palliation can be selected (Miettinen, 2000). It is diagnosed by clinical symptoms, chest X-ray, CT scan and bronchoscopy. CT scan is a more reliable diagnostic tool for cancer patients suffering from brain, lung or breast cancer and can detect the disease at a very early stage but not many hospitals are equipped with this facility because of its prohibiting cost (Koike *et al.,* 1999). Nevertheless, studies from India have shown that screening for cancer using CT scan and PET scan not only has a positive impact on survival, but is also reasonably cost-effective (Wittens *et al*., 1991; Marshall *et al*., 2001).

The growth of malignant tumours involves an abnormal synthesis of tissue which may be reflected in the serum proteins. Off late, serious attention has been given to the qualitative changes occurring in serum protein in neoplasia. Huggins and his colleagues (1950) have shown that the thermal coagulation of serum proteins, and there are even reports on the inhibition of the coagulation by iodoacetate, is altered in neoplastic disease (Broughton *et al*., 1951)

Extensive biochemical studies have been carried out on tumor tissue and peripheral blood to explore the aetiology of cancers and to establish tumor markers (Kshivets *et al*., 1992; Hansen, 1993). Warburg (1930) and Warburg and Christian (1943) have reported that cancer tissue exhibited a greater rate of aerobic glycolysis than normal tissue and for the first time suggested the study of biochemical markers in neoplasms. Extensive studies over the years have shown the significance of serum alkaline phosphate, serum amylase, serum lactate dehydrogenase, CEA, serum calcium, serum magnesium, serum copper, serum zinc, and the

copper/zinc ratio in various malignancies as possible diagnostic and prognostic biochemical markers (Hussain *et al.,* 1992; Chougule and Hussain, 1997; Chougule and Hussain, 1998; Chougule, 1999; Chougule *et al*., 2004; Chougule *et al.*, 2008). However, one did not come across any study, while scanning through the literature, on the role of AST and ALT in detecting malignancies of the head and neck, and cervix.

The process of transamination was first observed by Needhan (1960). Since then, AST and ALT have received wide application for diagnosis and prognosis. Increased levels of AST and ALT are commonly found in liver diseases, particularly in infective hepatitis. Pryse-Davis (1958) reported that in 50% of cancer patients with liver metastasis, the AST activity was elevated, and very high values were noted in patients with massive secondary involvement of the liver accompanied by extensive liver cell necrosis. Wilkinson (1962) reported that primary tumours of the large intestine were associated with elevated transaminase activity.

Cholinesterase is the best indicator available to assess the degree of exposure in different types of environmental stresses (Chougule *et al.*, 2008). Cholinesterase is an enzyme which hydrolyses ester of choline to give choline and the acid. Two types have been distinguished: true cholinesterase and pseudocholinesterase. A little literature is available regarding its values as a tumor marker. Ghooi *et al*. (1980) studied PChE levels in various malignancies and reported low PChE levels in advanced malignancies with hepatic metastases. Sen *et al*. (1987) studied PChE levels in healthy persons with oral leukoplacia and in patients with oral carcinoma; he observed diminishing activity with advancement of cancer and suggested PChE as a definite biochemical marker in the diagnosis and prognosis of oral malignancy.

CANCER DIRECTED TREATMENT (CDT)

At GCRI, 26,051 (61.46%) of cancer patients were given various CDT at GCRI and 38.54% didn’t receive any treatment after diagnosis. A total of 14,023 (59.72%) males and 12,028

(63.62%) females received CDT at GCRI Ahmedabad. The number and percentage of cancer cases by method of diagnosis are shown in Table 14 and Figure 20-22.

The percentage of patients treated for cancer at GCRI during the span of study is detailed in Table 15. Radiotherapy and chemotherapy were common modalities of treatment. 52.59% of patients had undergone radiotherapy alone or in combination with other forms of cancer directed treatment in both sexes. Second modality of treatment was chemotherapy (30.02%) alone or with other forms of CDT. Surgery (13.6%) alone or in combination with other forms of CDT was the third modality of treatment. (Table 16; Figure 23)

Chemotherapy, in addition to radiotherapy and surgery, is associated with improved overall survival in patients with oral cavity and oropharyngeal cancers. Induction chemotherapy is associated with a 9% increase in survival and adjuvant concomitant chemoradiotherapy is associated with a 16% increase in overall survival following surgery. In patients with unresectable tumours, concomitant chemoradiotherapy showed a 22% benefit in overall survival compared with radiotherapy alone (Furness *et al*., 2010).

Approximately 1 million newly diagnosed cancer patients are seen in India each year and out of these nearly 50-60% present themselves at a disease stage suitable for curative cancer-directed therapy (CDT) (GCRI Annual Report, 2007), which consists of surgery, chemotherapy and radiotherapy. Depending upon the cancer type and stage of disease, the initial therapy course is the most expensive period. Hence, a cancer patient and family members can face the double dilemma of confronting the cancer diagnosis and meeting the financial burden of CDT. Radiation therapy (RT) is a key treatment modality, two-thirds of all major cancers require RT with or without other the two types of treatment and approximately 40% of all cancer cures are directly attributable to the benefits of radiation therapy (Porter *et al*., 1999). Radiation therapy is delivered over a continuous period covering several weeks, mostly a curative aim of RT course lasts between 5 to 7 weeks. It is

often observed that patients may not receive this RT course, because it is of long duration needing to stay near a cancer centre/away from own home and the economic cost of therapy duration is unaffordable (Mathews *et al.*, 2009).This non-compliance can have serious implications in term of a curative disease progressing to an incurable stage and subsequent loss of life.

All cancer patients are treated with radiotherapy after surgery of breast cancer, oral cancer, lung cancer etc. and so the rate incidence of radiotherapy as a treatment of cancer is increasing. The radiotherapy is frequently recommended with chemotherapy. Only cancerous organ is exposed to radiation for killing the cancer cell is one of the major advantages of this therapy (Pal and Mittal, 2004). Hormone therapy is not effective for all the cancers and the cost of treatment is more, which makes it unaffordable for common patients. The regular dosage of chemotherapy which is recommended by doctors is much more costly for the major cancer patients (Kanavos, 2006). The medication cost is reflected in mortality rate of Indian cancer patients, while this rate is little less in developed country like America and Europe though the cancer incidence is much higher than the Indian population (Shavers and Brown, 2002).

A recent article in India Today, a popular weekly magazine, has reported this as a concern that healthcare is emerging as a branded product in our private hospitals (Datta, 2011). Even in the developed countries of the world, the high cost of cancer treatment often leads to financial hardships for patients and their families, including those with health insurance. In a 2006 survey in USA, almost a quarter of insured patients reported using most or all of their savings during treatment, and a similar proportion said their insurance plan paid less than expected for a medical bill. It is a challenge for this century's healthcare system to balance the expanding financial burden of cancer on one side, and the increasing incidence and prevalence of many types of cancer on the other side (Elkin and Bach, 2010)

CANCER MORTALITY

During the study period, 856 deaths in males and 451 deaths in female were registered (Tables 20 and 21). The mortality data were checked for matching with the morbidity data of cancer cases registered during study period. Unmatched data were termed as Death Certificate Only sources (DCOs), whose date of diagnosis was the same as date of death.

The number of DCOs during the 3 years was 56 & 21 for males and females respectively. DCOs accounted for 6.23% of the total deaths. Crude Mortality Rate (CMR), Truncated Mortality Rate (TMR) per 100,000 populations is shown in Table 15. Mortality to Incidence (M/I) percentage for all cancers in males was 21.65% and in females was 19.83%.

Total number and percentage of deaths by cancer during investigation is shown in Table 18 with five year age-groups by gender. Among all the age-groups, the Gender-specific mortality is found maximum in the age group of 50-54 years in both males and females (Figure-24). Age group of 00-04 years of female shows lowest gender specific percent mortality (0.44%) and 05-09 years of age group shows lowest mortality (0.56%) in males. Both these age-groups come under pediatric gender specific death of children at GCRI during the years of 2008 to 2010. In the age range of 50-69 years, the gender specific percent mortality in females was more compared to that in males of same age range (Table 18; Figure 24).

An age-specific cancer mortality rate for the year 2008-10 is presented in Table 19. Age specific cancer mortality rates were lowest in the age group of 00-04 years in both the sexes (1.6 males and 0.5 females) and highest in the age group of 70-74 years in both the sexes (195.2 males and 89 females). An age-specific cancer mortality rate is graphically represented in Figure 25.

In the survey, 70.79% of the cancer deaths occurred in individuals between the ages of 30 years and 69 years, with similar rates between men and women. In men, the top 3 cancer deaths were due to oral cancer at 23.13%, lung cancer at 12.27% and oesophagus cancer at 5.14% (Table 18). In women, the top 3 cancer deaths were due to breast cancer at 24.83%, cervical cancer at 14.63%, and oral cancer at 6.87% (Table 19). Tobacco-related cancers topped the list as 41.24% and 22.39% of cancers in men and women respectively were attributed to tobacco use. Tobacco-related cancer deaths were twice as likely to be a result of oral cancer, as compared to lung cancer.

At present, out of one million newly diagnosed Indian cancer patients each year, more than 50% will die within 12 months of diagnosis and another one million cancer survivors (within 5 years of diagnosis) will show progressive disease. Out of these 1.5 million in need of palliative care (PC), less than 0.1 million patients can be covered by the existing facilities. Since 1980s, the National Cancer Control Programme has identified that 'cancer patients with advanced stage require good palliative treatment.' Yet the establishment of PC clinics has not moved forward (Mohanti, 2002).

Projection estimates from the WHO has shown that by the year 2030, cancer will account for 12% of deaths in India (WHO, 2010). Currently lung cancer is the fourth largest cause of cancer mortality in India after cancers of the cervix and uteri, breast, lip and oral accounting for nearly 8% of all cancer related deaths in the country (Kumar *et al*., 2009). Among males, it is the leading cause of cancer mortality, accounting for 13% of all cancer deaths (Dorairaj and Vamadevan, 2009).

In developed countries, the probability of being diagnosed with cancer is more than twice as high as in developing countries. In rich countries, some 50 per cent of cancer patients die of the disease, while in developing countries, 80 per cent of cancer victims already have late-stage incurable tumours when they are diagnosed, pointing to the need for much better

detection programs. Around the world there are approximately 470,000 cases of cervical cancer diagnosed annually, 80 percent of which occur among women in developing countries. The vast majorities of women in developing countries currently have no options for avoiding this disease, despite the fact that it is highly preventable but marked as a first ranked in cancer mortality rate in Indian women (Shukla and Pal, 2004).

The results of our nationally representative mortality survey confirm that cancer is an important cause of adult deaths in India, with more than 70% of fatal cancers occurring during the productive ages of 30–69 years. Contrary to the common perception that cancer kills urban and educated people, Dikshit *et al*. (2012) noted that rates of cancer deaths were generally similar between rural and urban areas and about twice as high in the least versus the most educated. One in twenty-two men or women, aged 30 years, living today in rural India is likely to die of cancer before 70 years of age, based on the rates of actual deaths and in the absence of other disorders; in urban areas, the risks are one in 20 for men and one in 24 for women. Rural cancer registries, of which there are only two in India, might have low ascertainment of the incidence of cancer (NCRP 2010; Dhillon *et al*., 2011) because they report about half the incidence of cancer compared with registries in urban areas (panel). Even with possibly lower incidence of cancer, rural Indians have a higher prevalence of *beedi* smoking and tobacco chewing (but not cigarette smoking) (IIPS, 2010). Their cancers are diagnosed at a later stage and they have fewer cancer treatment facilities available to them. The very high levels of cancer deaths among illiterate women might represent deaths in a cohort of women older than 50 years who also had the highest prevalence of *beedi* smoking and tobacco chewing (IIPS, 2010; Jha *et al*., 2011) and perhaps other undetermined exposures associated with extreme illiteracy and poverty. Tobacco use is likely to be a strong explanation for the large differences in rates of cancer deaths by education (smoking is a key determinant of social differences in mortality in developed countries) (Jha *et al.,* 2006). Indeed, in men, the differences in oral cancers are consistent with higher prevalence of tobacco chewing in those who are illiterate, and the differences in lung cancers are consistent

with higher cigarette smoking in educated men (Gupta, 1996; IIPS 2010). The number of oral cancers was more than twice the number of lung cancers in individuals aged 30–69 years, indicating that the range of fatal cancers caused by tobacco in India differs substantially from that in high-income countries (Peto *et al*., 1992; Jha *et al.,* 2008; Jha, 2009). A large proportion of cancer deaths in the middle age (30–69 years) arise from tobacco-related cancers, particularly in the North-eastern states of India. A priority for cancer prevention is tobacco control, particularly through higher taxation of tobacco products to increase the very low levels of cessation (IIPS, 2010).

The number of people who die prematurely or suffer illness from tobacco use impose substantial health related economic costs to society. It is estimated that in the US, between 2000 and 2004, smoking accounted for 3.1 million years of potential life lost in men and 2.0 million years of potential life lost in women. Smoking, on average, reduces life expectancy by approximately 14 years (Jemal *et al*., 2008). Data from the Global Youth Tobacco Survey conducted during 2000-2007 found that among the youth of 13 to 15 years of age, 12% of boys and 7% of girls reported smoking cigarettes, and 12% of boys and 8% of girls reported using other tobacco products (Warren *et al.,* 2008). In every region of the world, the ratio of male to female smoking among youth was smaller than the ratio reported among adults, reflecting a global trend of increased smoking among female youth (Global youth tobacco survey, 2003).

In women, breast cancer mortality was similar in rural and urban India. Breast cancer is likely to be diagnosed at earlier stages in urban women than in rural women and is therefore more treatable. Trends recorded in urban cancer registries show an increase in the incidence of breast cancer of about 0·5% per year from 1991 to 2005, and an increase in the proportion presenting with localized breast cancer (Dhillon *et al.,* 2011), suggesting, partly, enhanced awareness and screening. Low-cost treatments, such as tamoxifen with surgery for early stage breast cancer, have helped to substantially reduce the breast cancer mortality rates in

the UK (Peto *et al.*, 2000) and could be implemented in urban facilities in India, but less so in rural areas.

Cervical cancer is the leading cause of cancer death in women from both rural and urban areas. The cervical cancer death rate of 16 per 100,000 reported in India suggests that a 30 year old Indian woman has about 0·7% risk of dying from cervical cancer before 70 years of age in the absence of other diseases. By contrast, the risk of dying during pregnancy for Indian women aged 15–49 years is about 0·6% (Registrar General of India, 2011).
An estimated 1,320 cancer deaths are expected to occur among children aged 0 to 14 years in 2011- about one third of these from leukemia. Although uncommon, cancer is the second leading cause of death in children, exceeded only by accidents. Mortality rates for childhood cancer have declined by 53% since 1975. The substantial progress in childhood cancer is largely attributable to improvements in treatment and the high proportion of pediatric patients participating in clinical trials (Arora *et al*., 2005).

The risk of death for women from cancers of regions like head and neck, oesophagus, stomach, liver and pancreas was significantly lower than that from cancers of breast and urinary bladder and this result was attributed to the gender differences in sub-site distributions of cancer in male and female (Micheli *et al.*, 1998).

Although cancer is the most common cause of disease related death in developed world, with improving survival rates, it has declined to approximately 30 per million per children (Gurney and Bondy, 2006; Stiller, 2007). In India, the mortality rate (adjusted to the world standardized population) varies from 14 to 34 per million children per year, and on first glance, it appears similar to or even greater that the developed world. However, the incidence of childhood cancer in some areas of India (Delhi, Mumbai, Kolkata etc.), is much less than other parts of world and the Mortality:Incidence (M:I) ratio rather than the mortality rate gives a more accurate picture of death from childhood cancer. This varies from

17% to 72% in India as compared to 20 to 24% for USA and Britain respectively (Gurney and Bondy, 2006; Stiller, 2007), and is particularly high in rural Ahmedabad (61%) and Barshi (72%). Among the major urban areas, the mortality rates as well as M:I ratio in Mumbai is 1.5 to 2 times higher than that of Bangalore, Bhopal, Chennai and Delhi. The reliability of these statistics depends on the comprehensiveness of death notification and the quality of death certification, which is much higher in Mumbai, than other areas of India (Yeole, 2007). Therefore, data for Mumbai is probably a truer estimate of mortality in urban India. The largest contributors to mortality from childhood cancer in Britain are CNS tumours, reflecting the relatively poor survival in this group, followed by leukaemias and neuroblastomas. In contrast, in India, leukemia continues to be the largest contributor to cancer related mortality in children followed by lymphomas and CNS tumours, which have similar mortality rates. The pattern is a result of the relatively high incidence of lymphomas, low incidence of CNS tumours, and lower survival of all cancers, including leukemias in India (Arora *et al*., 2012).

CONCLUSION

This work is just a brief insight in the broad and complicated field of cancer. This piece of research will act as a platform for further work in various parts of the country in this area. Hence we conclude that Cancer is one of the most formidable health problems. It is the second leading cause of death in the World. Half of all Men and one third of all Women will develop cancer during their lifetimes. Today millions of people are either living with cancer or have had cancer.

The risk of developing cancer can be greatly reduced by avoiding activities that contribute to its development. Abstaining from smoking, heavy drinking and excessively exposing oneself to the sun can significantly bring down the chances of cancer associated risks. Good nutrition and regular exercise may lower the risk as well. Choosing a diet low in fat and high

in fruits, vegetables and fiber also helps prevent cancer. In some cases, chemoprevention- use of certain synthetic drugs or natural agents- also seems to reduce the risk of cancer.

There are many approaches for treating cancer, the most popular being Surgery, Radiation and Chemotherapy. The greatest progress in recent years has been the development of conceptually sound, experimentally tested and therapeutically superior and more effective treatment regimens consisting of combinations of antineoplastic or cytotoxic agents. Cancer chemotherapy with combinations of antineoplastic agents has now become a standard component of most treatment strategies.

The detailed scheduling of drugs in this combination chemotherapy varies from cancer to cancer, patient to patient, and is therefore left to the specialist to design and outline the specific treatment regime for the individual patient.

Current research is not an end but a beginning with good beliefs and a new hope in various areas of cancer research.

During the course of the present study, details of the cancers registered to GCRI, Ahmedabad for the years 2008 to 2010 were collected and analysed to understand the prevalence, possible aetiology, treatment, survival and death due to cancer. As expected, an increase in the incidence of cancer was observed for the span of study as compared to yester years. Moreover, an upward trend of female registration was very apparent, compared to similar data from the past, with the ratio of the female to male registered cases getting narrowed. Though, this trend is akin to that of global pattern, a possible change in the socio-cultural fabric of our society, wherein women in the recent times are encouraged to seek medical help compared to past, might have also contributed to the shift in this ratio. Nonetheless, we could not gather supportive data to conclusively prove this notion.

Further, age adjusted data analysis revealed that 82% of cancer cases were reported from individuals above the age of 35 years. Considering the facts that the proportion of population in this age group (>35 years) is only 34% and that this is the prime productive time in a man's life, special attention needs to be directed towards curbing this ghastly menace in our society.

Efforts were also made to identify the leading sites of cancer and the results revealed that the mouth is the most affected site in men whereas in females, breast cancer ranked first among the various cancers. Further analysis of the data at hand revealed that the indiscriminate use of tobacco could be the prime reason for the increased incidence of oral cancer in men. However, changes in dietary patterns with the western foods invading our traditional meals could be suspected as a major trigger in the escalating trend of breast cancer in women from this region, who were otherwise believed to be refractory to the development of breast cancer due to BRCA polymorphism.

The paediatric age group (0-14 years) nevertheless, was found to be more prone to leukaemia over other types of cancer. However, here too one observed a gender bias with more cases reported in male than that in females. In order to elucidate the exact reason for such a variation, one needs a careful cultural as well as demographic analysis of the society *viz.* percentage prevalence of gender bias, if any, in the society in seeking healthcare or an estimate of male predominance in the societal population. Unfortunately, we could not gather information of this nature and hence are unable to comprehend the real reason behind the gender bias in leukaemia patients.

Cancers to the mouth and lung were found very frequently in the population analysed, especially in men. However, knowing the possible aetiology it is but natural to suspect a casual relationship between these cancers and the prevalence of tobacco usage among the affected population. The corroborative evidence collected reaffirms the existence of a strong

positive correlation between the two above-cited variables. Hence, we believe that in addition to the intensive efforts made by the government, more community level awareness needs to be developed aggressively to eradicate this life-threatening habit form the society at large in order to have a healthy generation in the future.

Lastly, a comprehensive discussion on the various methods of cancer diagnosis used across the world has been made. The review revealed that most of the modern diagnostic tools employed routinely elsewhere in the world are too expensive and hence found to be out of reach of the economically weak, which happens to be the bulk of the population in our society. Hence, early cancer detection remained a distant reality in India. This needs urgent attention since early detection can certainly save the life or prolong the life of a cancer patient. Attempts were also made in the current study to analyse the data regarding the cancer directed treatment, survival and mortality. However, the data at hand were insufficient to arrive at a logistical conclusion. We require a robust demographic record highlighting finer details of health and socio-economic milestones at various age classified groups to make a realistic cancer registry with future predictive value. For a country like India, this task appears herculean but nonetheless achievable. It is therefore hoped that the national population register will come up with the above details for a socially secure nation with a healthy populace in their next edition.

Table 1: Distribution of cancer cases collected from Population Based Cancer Registry: (PBCR) Ahmedabad 2008-2010

SOURCE	REGISTERED	%
GCRI	15837	73.5
Urban Sources	4858	22.5
Rural Sources	662	3.1
Out Side Ahmedabad	202	0.9
TOTAL	**21559**	**100.0**

Figure 1: Distribution of cancer cases recorded in the PBCR Ahmedabad during 2008-2010

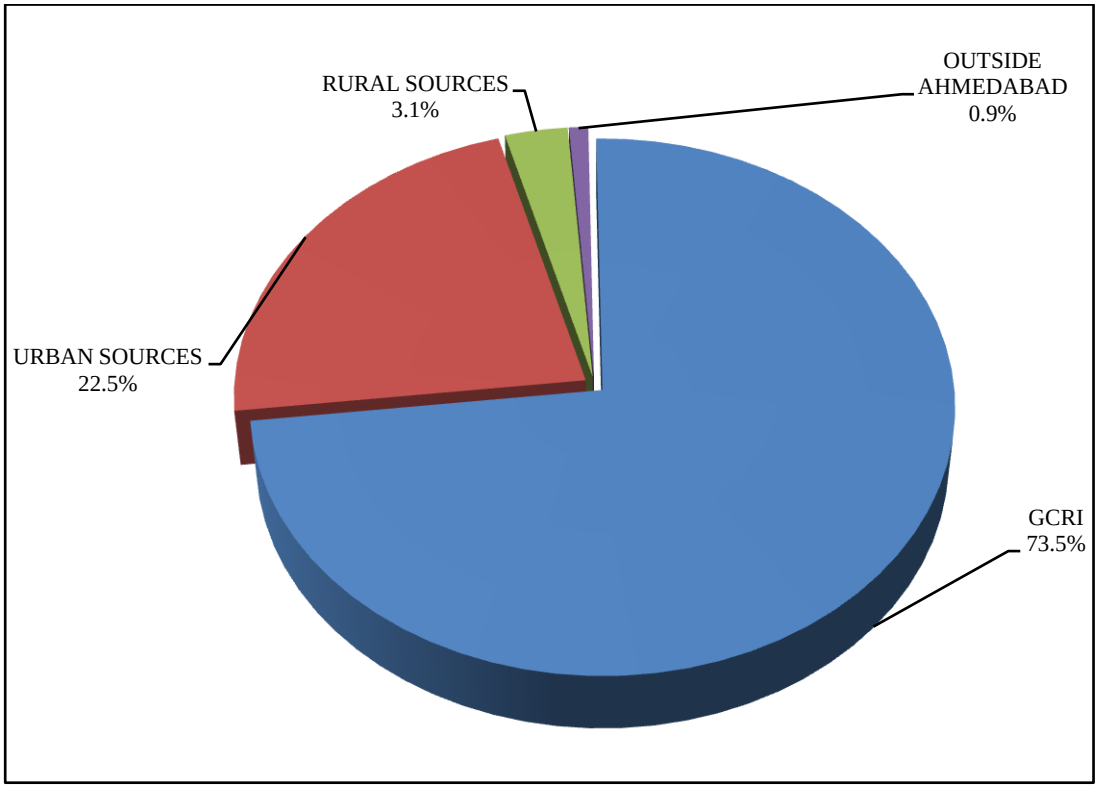


Table 2: Age-wise distribution of total cancer cases for each sex during the years 2005 to 2007 collected from sources at Ahmedabad

Age in years	Male		Female		Total	
	Number	%	Number	%	Number	%
00-04	544	1.86	218	1.28	762	1.64
05-09	527	1.8	170	0.99	697	1.5
10-14	512	1.75	207	1.2	719	1.55
15-19	620	2.11	233	1.36	853	1.83
20-24	638	2.18	292	1.7	930	2.02
25-29	738	2.52	522	3.04	1260	2.7
30-34	1165	3.98	998	5.81	2163	4.66
35-39	1754	5.99	1620	9.43	3374	7.26
40-44	2489	8.5	2269	13.21	4758	10.24
45-49	3120	10.65	2624	15.28	5744	12.37
50-54	4073	13.91	2319	13.5	6392	13.76
55-59	3467	11.83	1642	9.57	5109	10.99
60-64	3669	12.53	1735	10.1	5404	11.63
65-69	2749	9.39	1142	6.65	3891	8.38
70-74	2067	7.06	719	4.19	2786	5.99
75-79	737	2.52	254	1.48	991	2.13
80+	415	1.42	210	1.21	625	1.35
Total	**29284**	**100**	**17174**	**100**	**46458**	**100**

Figure 2: Frequency distribution in percentage of cancer cases among various age-groups in males (2005-2007)

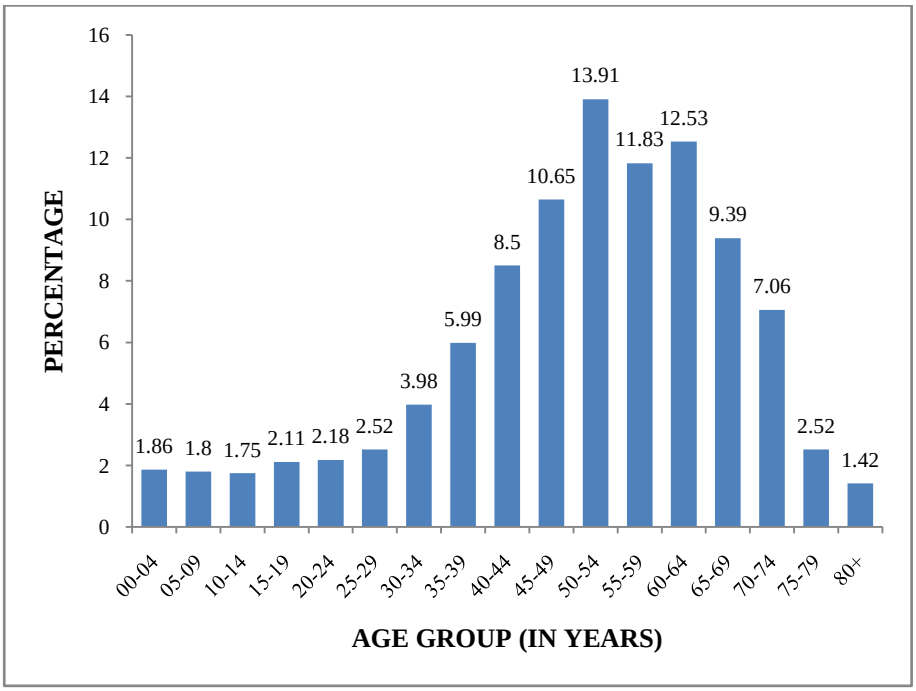


Figure 3: Frequency distribution in percentage of cancer cases among various age-groups in females (2005-2007)

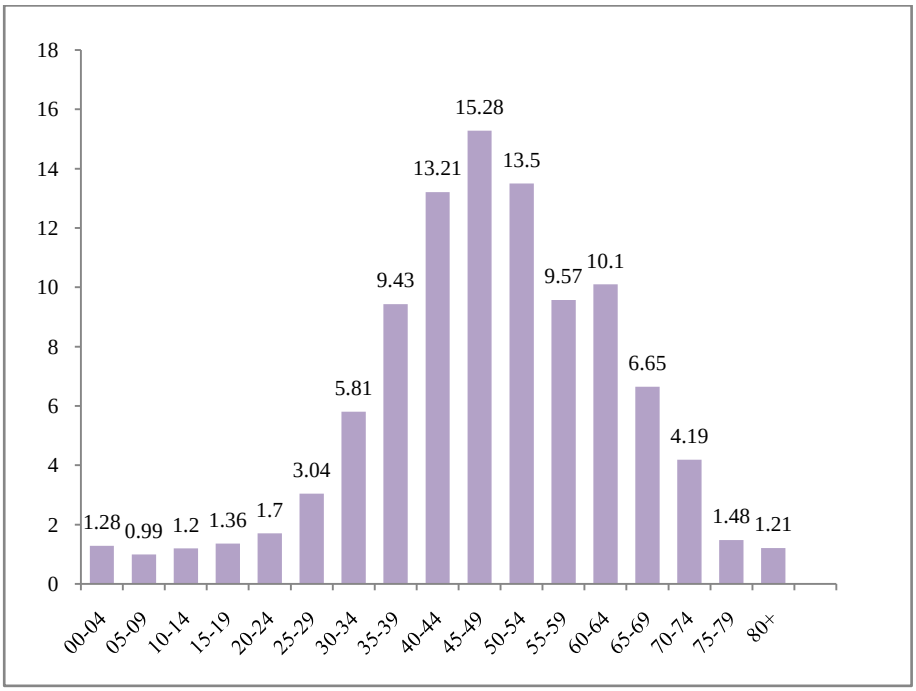


Table 3: Age-wise distribution of total cancer cases for each sex during the years 2008 to 2010 collected from sources at Ahmedabad

Age in years	Male		Female		Total	
	Number	%	Number	%	Number	%
00-04	759	1.88	369	1.34	1128	1.66
05-09	789	1.95	295	1.07	1084	1.59
10-14	727	1.8	402	1.46	1129	1.66
15-19	897	2.22	388	1.41	1285	1.89
20-24	917	2.27	513	1.87	1430	2.1
25-29	1059	2.62	850	3.09	1909	2.81
30-34	1666	4.12	1598	5.8	3264	4.8
35-39	2459	6.08	2668	9.68	5127	7.54
40-44	3484	8.61	3652	13.26	7136	10.49
45-49	4395	10.86	4227	15.35	8622	12.68
50-54	4670	11.54	3722	13.51	8392	12.33
55-59	4842	11.96	2628	9.54	7470	10.98
60-64	5192	12.83	2675	9.71	7867	11.58
65-69	3897	9.6	1812	6.58	5709	8.39
70-74	3071	7.59	1163	4.22	4234	6.22
75-79	1069	2.64	369	1.34	1438	2.11
80+	580	1.43	213	0.77	793	1.17
Total	**40473**	**100**	**27544**	**100**	**68017**	**100**

Figure 4: Frequency distribution in percentage of cancer cases among various age-groups in males (2008-2010)

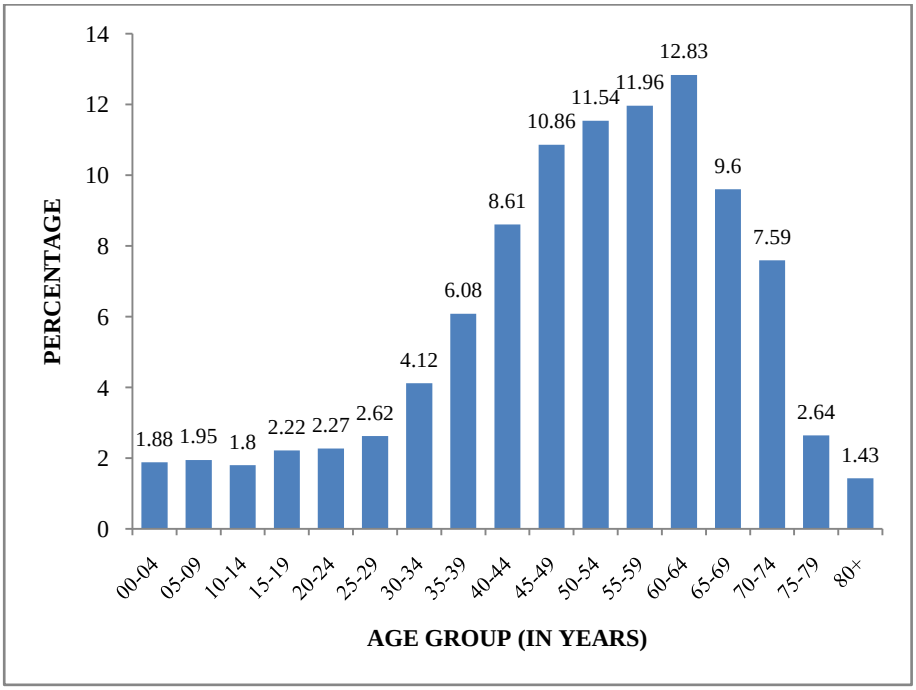


Figure 5: Frequency distribution in percentage of cancer cases among various age-groups in females (2008-2010)

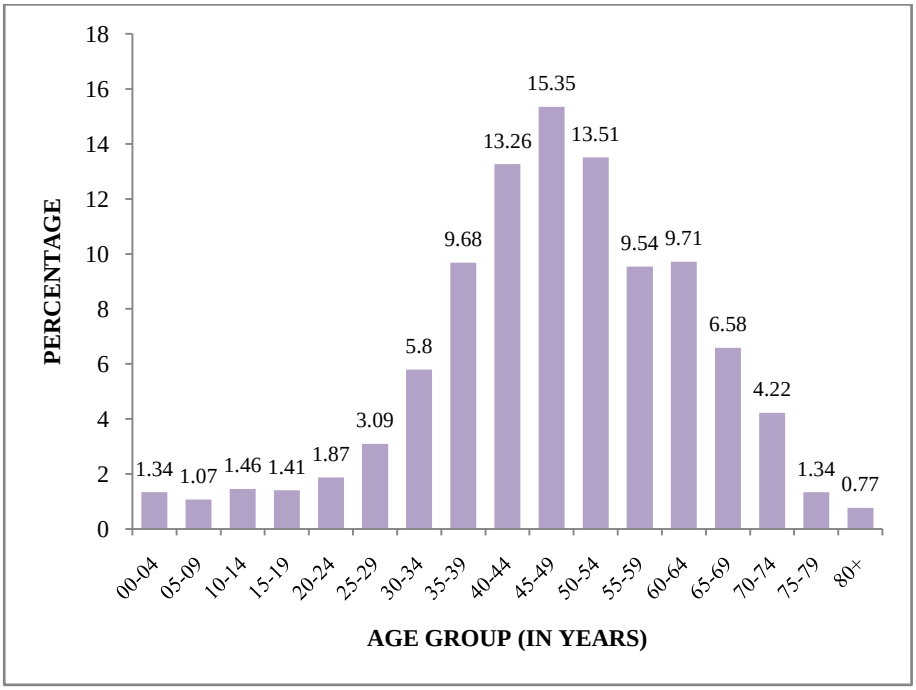


Table 4: Gender-specific percent incidence cancer cases for the years 2008, 2009 and 2010

Year	Male		Female		Total	
	Number	**%**	**Number**	**%**	**Number**	**%**
2008	2346	20.99	2062	20.86	4408	20.59
2009	3648	30.64	3295	30.91	6943	32.2
2010	5195	48.36	5013	48.23	10208	47.21
Total	**11189**	**100**	**10370**	**100**	**21559**	**100**

Figure 6: Reported incidence (in percentage) of cancer among males and females for the years 2008 to 2010

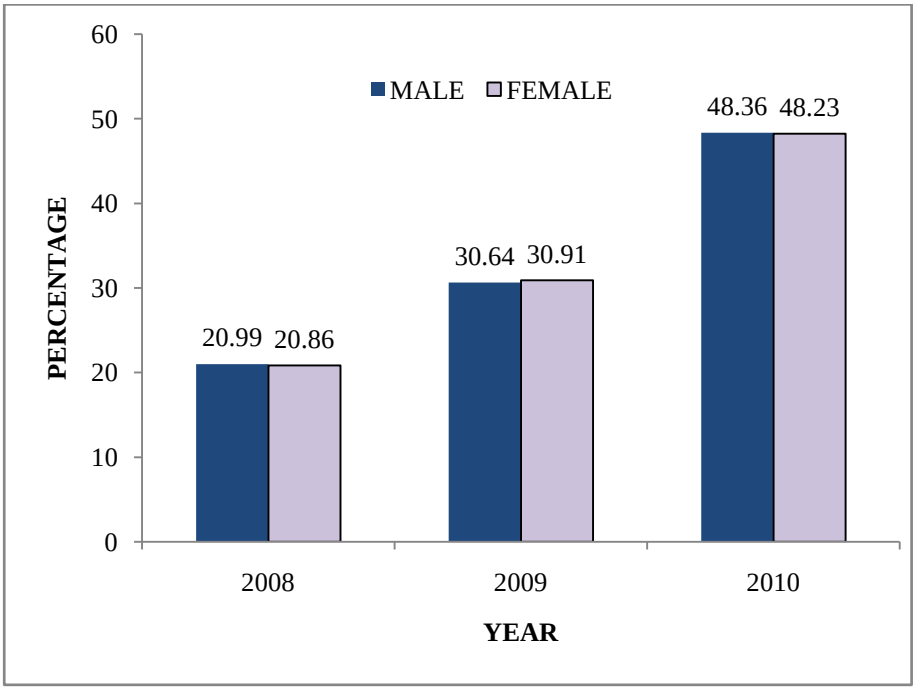


Table 5: Incidence of cancer cases, in percentage, amongst various age-groups in the population analysed

AGE GROUP	POPULATION (%)			CANCER CASES (%)		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**
00-14	32.9	31.34	32.12	4.6	4.82	4.71
15-34	34.6	34.18	34.39	12.6	12.9	12.75
34-64	27.89	28.31	28.1	63.31	65.4	64.355
65+	4.61	6.17	5.39	19.49	16.88	18.185

Figure 7: Proportion of population in various age-groups and the incidence of cancer amongst males

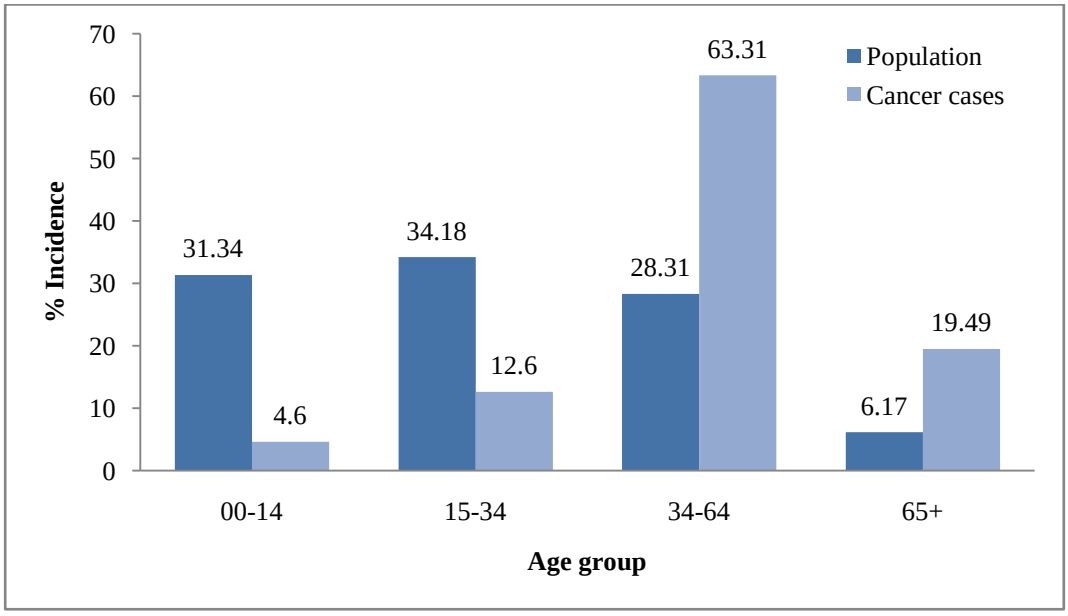


Figure 8: Proportion of population in various age-groups and the incidence of cancer amongst females

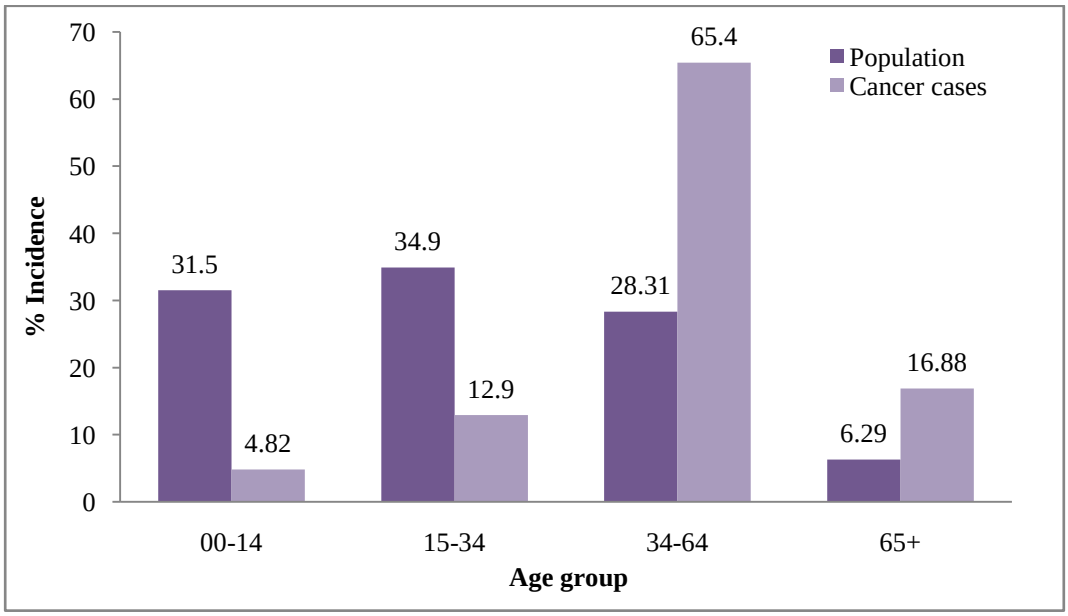


Table 6: Average Annual Age specific, Crude (CR), Age Adjusted (With standard Error (SE) and Truncated (30-69 years) (TR) Incidence Rate per 100,000 population: 2008-2010: Male

Code	AGE GROUP																			
ICD 10	**0-4**	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**	**65-69**	**70-74**	**75+**	**CR**	**AAR**	**SE**	**TR**
C00									0.5	1.5	4.3	1.6	3.6				0.4	0.5	0.17	1.7
C1-2				0.3		3.4	5.7	10.7	9.2	23.4	23.1	37.8	26.1	27.7	31.2	21.4	7.3	8.8	0.69	20.4
C3-6				0.3	0.4	5.9	6.1	15.4	26.4	33.6	49.2	69.3	45.3	69.8	17.4	38.8	12.5	14.7	0.88	37.3
C7-8						0.3	0.6	0.5	0.7	0.6	1.9					4.4	0.4	4.5	0.12	0.6
C9					0.3	0.5	1.1		0.5	2.2	4.3	8.9	14.1	9.1	6.8	8.7	1.5	2.1	0.34	4.2
C10							0.2	0.5	0.5	0.6	2.6	3.1	3.4	2.4	3.4	8.7	0.6	0.8	0.22	1.6
C11										2.1	0.8	1.5					0.2	0.2	1.11	0.7
C12-13						0.3	1.1	1.1	0.7	7.2	7.1	16.6	24.6	16.1	34.7	30.2	3	4.4	0.52	8.2
C14									1.9	1.4	3.7	10.4	7.2	18.3	7.1	12.9	1.4	2.1	0.35	3.5
C15						0.4	1	3.1	6.3	4.9	11.7	25.4	33.2	25.5	41.2	47.6	4.5	6.4	0.64	12.2
C16						0.3	1.1	2.3	2.2	2.5	1.9	3	7.1	4.5	24.3	13.1	1.4	1.9	0.33	3
C17					0.3			0.4			0.9			2.5			0.2	0.2	0.08	0.2
C18		0.3	0.5	0.7			3.2		5.2	5.3	6.2	9.1	19.1	9.3	10.2	8.8	2.4	8.1	0.4	6.7
C19-20					0.5	0.8	0.4	1.2	0.5	2.1	2.5	13.6	12.2	6.8	20.8	13	1.7	2.4	0.38	4.5
C21					0.4				0.5				1.8	2.2	3.4	4.2	0.2	0.4	0.15	0.3
C22	0.4							0.4	1.2	1.4	2.7	9	10.4	9.3	17.4	8.6	1.3	1.9	0.34	3.5
C23-24								0.5		0.6	0.8	10.6	10.5	2.4	10.5		0.8	1.2	0.28	3.1
C25										2.6		4.5	1.6		6.9		0.4	0.6	0.17	1.2
C30-31							0.5	0.4		0.6		1.6	1.7	2.3			0.2	0.3	0.11	0.7
C32					0.4		0.4		2.1	3.5	9.8	12.1	19.3	27.8	17.2	34.5	2.7	4.1	0.5	6.7
C33-34							0.9	1.2	2.1	10.8	12.6	28.5	36.8	46.4	58.9	51.8	5.2	7.7	0.7	13.2
C37-38											0.8		1.2	4.7	3.6	4.3	0.2	0.4	0.16	0.4
C40-41		0.5	1	1.1			0.5	0.5	0.7	1.3	2.7	3.2	1.5	2.2	3.6		0.8	0.9	0.2	1.5
C43						0.4						1.5	3.6	2.3			0.2	0.3	0.13	0.6
C44				0.4	0.7	0.8		1.7	0.6		0.8	3.1			6.8	4.5	0.6	0.7	0.18	1
C45															3.4		0	0.1	0.06	
C47-49	0.5	0.9		0.3	0.3	0.6		0.5			0.9	1.5	1.8		3.4	4.5	0.5	0.6	0.18	0.7

Code	AGE GROUP																			
ICD 10	**0-4**	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**	**65-69**	**70-74**	**75+**	**CR**	**AAR**	**SE**	**TR**
C50							0.9	3.2	1.2	1.3	2.8	4.5	1.6	4.7		4.3	0.9	1	0.23	2.3
C60							0.9	1.1		4.2	1.6	10.6	5.3	2.4		4.3	1	1.1	0.25	3.3
C61											3.5	4.6	7.1	3	44.5	64.9	2.1	3.8	0.52	2.1
C62	1			0.3	1		2.1	1	0.5	2.2							0.5	0.6	0.15	0.7
C64	1.9	0.9							1.6	1.5	3.5	6.1	5.3	13.8	3.5		1.2	1.6	0.31	2.6
C65													1.5				0	0.1	0.05	0.2
C67									0.6	1.3	1.6	4.4	8.9	13.8	3.4	21.6	1	1.6	0.34	2.3
C69	1.2											1.2	0.1				0.1	0.2	0.09	0.2
C70-72		0.8	1.5	1.7	1.9		0.5	0.6	0.2	1.3	5.4	3.1	5.1	9.3	3.4	8.7	1.4	1.7	0.31	2.5
C73						0.8	0.4	1.2				4.5	1.6	4.7		4.4	0.5	0.6	0.2	1
C74									0.6								0	0	0.02	0.1
C77					0.8	1.8	1.5	2.2	2.1	2.6	10.8	18.1	15.4	23.2	31	38.9	3.2	4.5	0.52	6.8
C78						0.5		1.7	1.8	4.8	5.3	12.2	11.9	4.7	7	25.9	1.9	2.6	0.4	5.6
C79								0.5	0.6		2.8	4.4	1.6	2.4	3.4	4.4	0.5	0.7	0.21	1.5
C81		1.2	0.5	1.4		0.6	0.5	0.5	1.2	0.6	1.7	1.6	3.7				0.8	0.9	0.18	1.4
C82	0.9	0.5	0.4	0.6	2.4	1.5	0.5	1.5	1.2	6.5	9.7	9.3	14.2	4.6	6.9	21.7	2.6	3.3	0.42	6.4
C90								0.9		1.2	2.8	3.1	1.7		17.2	8.7	0.7	1	0.24	1.5
C91	2.9	1.8	0.9	4.5	4.5	1.1	1.2	1	1.2	1.5	0.9	3.1		9.1	3.4	13	1.4	1.8	0.31	1.2
C92-94	0.5	0.8	0.8	1.1	1.2	1.9	2.1	5.3	3.3	2.8	1.9	1.4	5.1	4.7	13.8	4.3	2.1	2.2	0.32	3.4
C95		0.4	0.4		0.6					1.6		1.6					0.3	0.4	0.1	0.5
O&U				0.3	0.3	2.4		1.6	2.3	3.4	6.2	1.6	10.5	4.5	6.9	12.9	1.7	1.9	0.33	4.1
All	**9.3**	**8.1**	**6**	**13**	**16**	**24.3**	**33.4**	**62.7**	**80.2**	**145**	**211.8**	**371.3**	**386.7**	**396.5**	**476.6**	**558**	**74.5**	**107.9**	**14.89**	**187.4**

Table 7. Average Annual Age specific, Crude (CR), Age Adjusted (With standard Error (SE) and Truncated (30-69 years) (TR) Incidence Rate per 100,000 population: 2008-2010: Female

Code	AGE GROUP																			
ICD 10	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+	CR	AAR	SE	TR
C00															2.1	3.5	0.1		0.2	0.04
C1-2							1.1	1.7	4.8	4.2	9.2	9.8	11.6	6.4	3.4	10.2	2.3	2.6	0.35	5.9
C3-6					1.5	1.2	1.7	1.2	5.1	3.5	9.8	6.4	11.2	6.7	6.1	20.1	2.4	2.9	0.38	0.56
C7-8									1.3		1.2	1.7			3.2		0.3	0.36	0.16	0.53
C9											1.2	1.7	1.6	2.6			0.2	0.35	0.14	0.58
C10												1.4					0	0.2	0.14	0.19
C11															2.9		0	0.1	0.05	0.01
C12-13					0.4			1.7	1.8	1.4	6.9	3.2	2.1	1.9	6.5	6.4	1.2	1.3	0.21	2.6
C14					0.3	0.2	0.3			0.9	1.2	1.9					0.2	0.2	0.1	0.51
C15						0.2	0.3	1.5	2.4	4.7	2.2	99.8	16.3	15.4	19.1	37.1	2.9	3.8	0.43	6.9
C16									1.2	4.1	3.3	3.2	3.4		6.2	3.8	0.9	1.1	0.22	2.5
C17									0.6	0.7							0	0	0.04	0.1
C18				0.3			1.2			1.4	3.5	3.1	3.6	6.8	24.6	10.1	1.3	1.7	0.31	1.9
C19-20				0.4	1.1			1.2	0.6	1.6	2.2	3.1	5.2	8.9	24.6		1.4	1.6	0.3	2.2
C21								0.5	1.2	0.9	2.1	1.7	3.2	6.7	0.5	0.5	0.18	1.2		
C22				0.3	0.4		0.4		0.6		1.2		3.3	4.5			0.5	0.5	0.16	0.6
C23-24						0.5	1.7	1	0.6	7.1	7.9	6.1	6.5	4.2	5.9	3.2	1.7	1.8	0.31	4.8
C25								1.1	1.2	0.6	1.1		1.7	2.5	3.1	9.2	0.5	0.7	0.16	0.7
C30-31					0.6	0.5	0.3		0.5			4.2	3.1		2.9		0.4	0.6	0.17	1.3
C32											1.2	1.5			2.9		0.1	0.1	0.08	0.2
C33-34										0.6	4.2	11.4	6.2	17.3	18.3	13.2	1.7	2.2	0.38	3.2
C37-38		0.5									1.2					6.5	0.2	0.2	1.1	0.2
C40-41	0.5	0.2	0.6	0.5	0.9	1.1	0.4	0.5		0.8	1.2	3.1				3.1	0.6	0.7	0.19	0.8
C43									0.2	0.6			1.4		2.9	6.6	0.2	0.3	0.14	0.5
C44							0.4	0.5	0.5	0.9					9.3	6.5	0.4	0.6	0.13	0.4
C45										0.6							0	0	0.01	0.1
C47-49	0.6			0.3			0.5	0.5	1.4								0.3	0.3	0.12	0.3

Code	AGE GROUP																			
ICD 10	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+	CR	AAR	SE	TR
C50					1.1	4.2	13.8	21.9	41.9	65.8	89.6	72.9	64.5	90.4	82.8	59.6	24	24.9	1.16	56.3
C51								1.3	0.8		0.8	3.1	3.2		3.1		0.3	0.4	0.17	1.4
C52					0.3							8.1	3.6	2.2	3.6		0.5	0.6	0.23	1.5
C53				0.3		0.4	2.6	7.8	17.3	17.1	36.1	42.3	26.2	47.5	33.2	22.5	8.6	10.3	0.78	22.8
C54						0.6	0.5			3.8	9.1	11.2	9.8	10.6	5.9	6.4	1.5	2.2	0.36	5.1
C55								1.1		0.6	2.1	3.3	6.5	4.2	3.3	6.4	0.6	0.9	0.21	2.1
C56			0.2	1.1	1.6	2.2	2.9	2.6	5.8	9.6	21.9	12.9	23.6	11.2	22.6	10.9	6.3	4.9	0.52	11.2
C57									0.3	0.6	0						0	0	0.04	0.1
C64								0.1	0.6	0.7		7.9	1.8				0.4	0.6	0.13	1.4
C66																				
C67									0.3	0.6	1.2	4.9	3.5	1.9		6.7	0.5	0.6	0.19	1.4
C70-72	1.4	0.9		0.8				1.9		1.6	3.3	6.5		3.2		3.2	0.7	0.9	0.21	1.1
C73				0.9	0.5	0.7	1.2		0.7		1.3		1.5		3.2	3.2	0.5	0.6	0.18	0.4
C77			0.4				0.4		1.8	2.3	3.5	3.2	3.4	4.3	15.3	6.7	1.1	1.3	0.27	2.1
C78						1.1	2.1	1.2	1.8	1.5	3.5	4.9	11.5	8.5	8.2	16.2	1.9	2.4	0.35	3.8
C79						0.2	0.5		1.2				3.3	2.2	3.2	6.6	0.5	0.6	0.13	0.7
C81						1.2			0.5	0.9				2.2		3.3	0.3	0.3	0.13	0.3
C82						2.1	1.6	2.1	1.2	4.6	7.9	4.7	3.3	12.8	12.3	16.4	2.1	2.4	0.37	3.9
C90											1.2	1.5	1.5	4.5		3.3	0.3	0.4	0.16	0.6
C91		2.2	0.6	0.8		1.1		1.2		0.7	1.2	3.1	5.2	2.2	6.1		1	1.1	0.25	1.6
C92-94		0.5	1.5	0.5	1.1	1.4	2.3	0.4	6.9	3.9	4.6	4.6	5.3	4.2	3.2	3.3	2.2	2.2	0.33	4.2
C95				0.3				0.6							3.1		0.1	0.1	0.08	0.1
O&U			0.4		0.5	0.4	1.2		0.5	3.2	2.1	1.7	6.7	4.4	3.2	6.5	1	1.2	0.26	2.2
All	**2.5**	**4.3**	**3.7**	**6.5**	**10.3**	**19.3**	**37.4**	**53.6**	**105.6**	**152.1**	**250.2**	**360.1**	**264.8**	**300.4**	**356.8**	**321.2**	**74.38**	**84.31**	**12.49**	**161.92**

Table 8: Proportion of cancer cases per 100,000 people amongst various age-groups during the years 2008 to 2010 in the population analysed

Age Groups	2008		2009		2010		Total	
	Males	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**
00-04	4.9	7.6	5.1	7.9	5.9	7.93	**5.3**	7.81
05-09	7.2	3.6	7.56	3.3	7.8	3.38	7.52	**3.43**
10-14	6.54	5.1	6.59	5.12	6.68	5.17	6.6	5.13
15-19	11.4	7.2	11.51	7.29	12.4	7.35	11.77	7.28
20-24	11.2	8.2	11.37	8.9	11.6	8.9	11.39	8.67
25-29	2.01	12.6	20.8	12.78	21.12	12.78	14.64	12.72
30-34	32.5	33.1	32.6	33.98	33.84	34.6	32.98	33.89
35-39	39.2	45.6	40.15	45.5	40.56	45.89	39.97	45.66
40-44	65.3	85.4	65.9	85.43	68.1	87.7	66.43	86.18
45-49	84.1	112.6	84.5	112.97	84.68	114.17	84.43	113.25
50-54	180.6	152.2	180.63	152.45	180.92	153.08	180.72	152.58
55-59	262.3	132.5	262.9	132.8	264.8	133.4	263.33	132.9
60-64	258.3	136.5	258.7	136.6	259.4	136.81	258.8	136.64
65-69	277.7	153.64	278.2	154.1	278.6	155.6	278.17	**154.45**
70-74	259.7	125.8	259.9	126.23	260.2	126.59	259.93	126.21
75+	350.3	105.6	350.96	105.62	350.95	105.6	**350.74**	105.61

Figure 9: Changes in the cancer incidence with respect to age-group

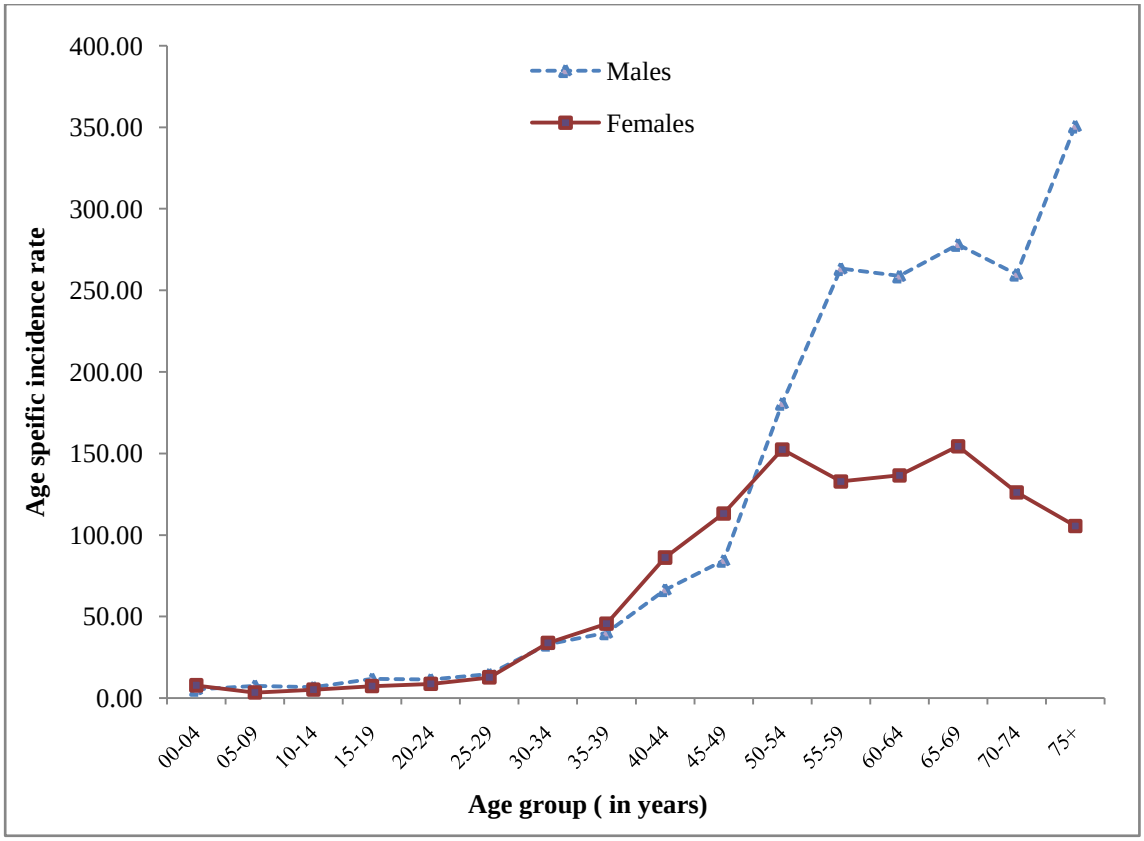


Table 9: Ten leading sites of cancer reported among males and females in the studied population

MALE			FEMALE		
Site	**Number**	**%**	**Site**	**Number**	**%**
1. Mouth	2689	24.03	1. Breast	3149	30.37
2. Tongue	1216	10.87	2. Cervix/Uterine	1314	12.67
3. Lung	637	5.69	3. Ovary	913	8.8
4. Oesophagus	583	5.21	4. Oesophagus	461	4.45
5. Hypopharynx	582	5.2	5. Mouth	364	3.51
6. Larynx	465	4.16	6. Myeloid leukaemia	348	3.36
7. NHL	385	3.44	7. NHL	341	3.29
8. Colon	358	3.2	8. Tongue	318	3.07
9. Prostrate	316	2.82	9. Uterus	291	2.8
10. Myeloid leukaemia	258	2.31	10. Gallbladder	255	2.46
Other sites	3700	33.07	Other sites	2616	25.22

Figure 10: Ten leading sites of cancer noted amongst males during 2008-2010 at Ahmedabad

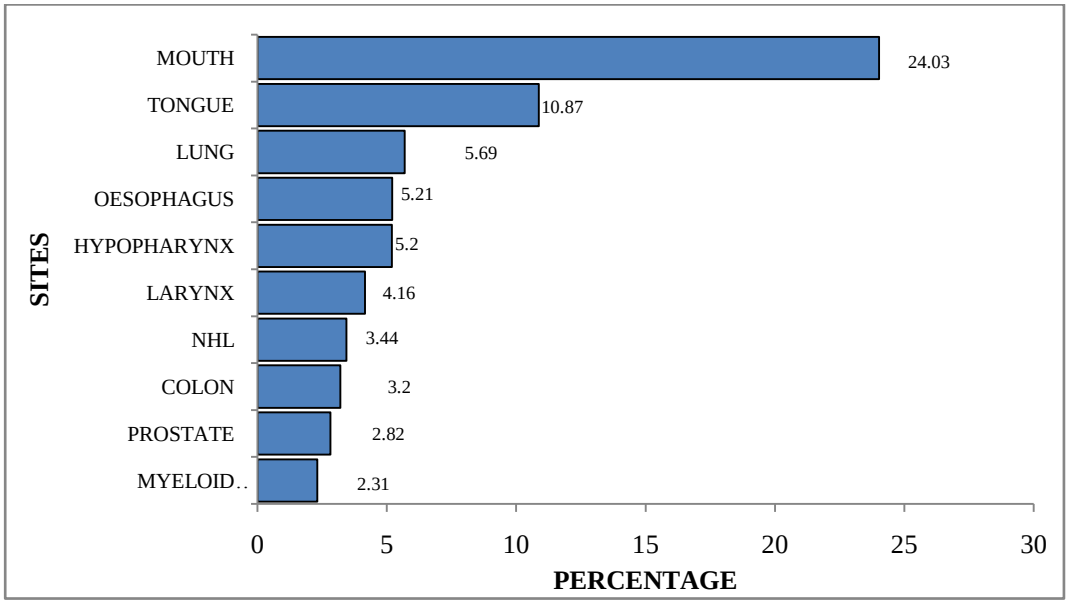


Figure 11: Ten leading sites of cancer noted amongst females during 2008-2010 at Ahmedabad

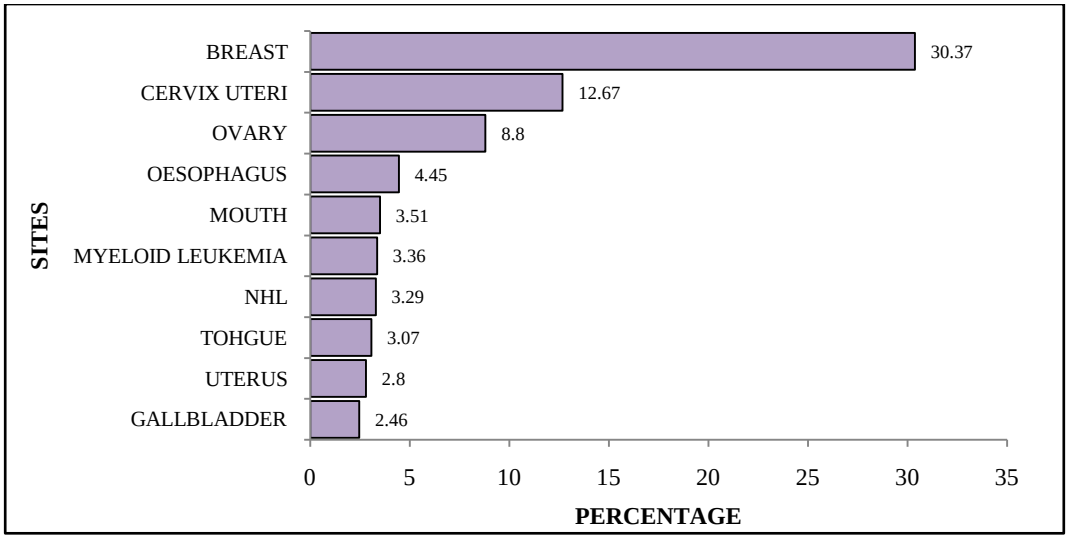


Table 10: Five leading sites of cancer in males and females observed amongst the studied population at Ahmedabad during 2008-2010

Male			Female		
Site	**Number**	**%**	**Site**	**Number**	**%**
1. Mouth	2689	24.03	1. Breast	3149	30.37
2. Tongue	1216	10.87	2. Cervix/Uterine	1314	12.67
3. Bronchus & Lung	892	7.97	3. Ovary	913	8.8
4. Oesophagus	583	5.21	4. Oesophagus	461	4.45
5. Hypopharynx	582	5.2	5. Tongue	318	3.07
Other sites	5227	46.72	Other sites	4215	40.64

Figure 12: The first five leading sites of cancer: Male

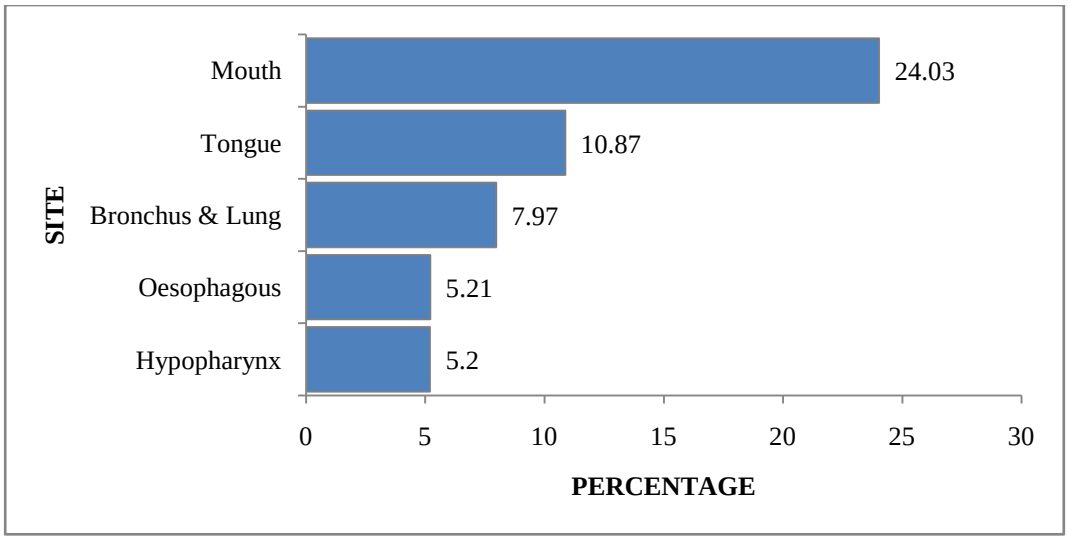


Figure 13: The first five leading sites of cancer: Female

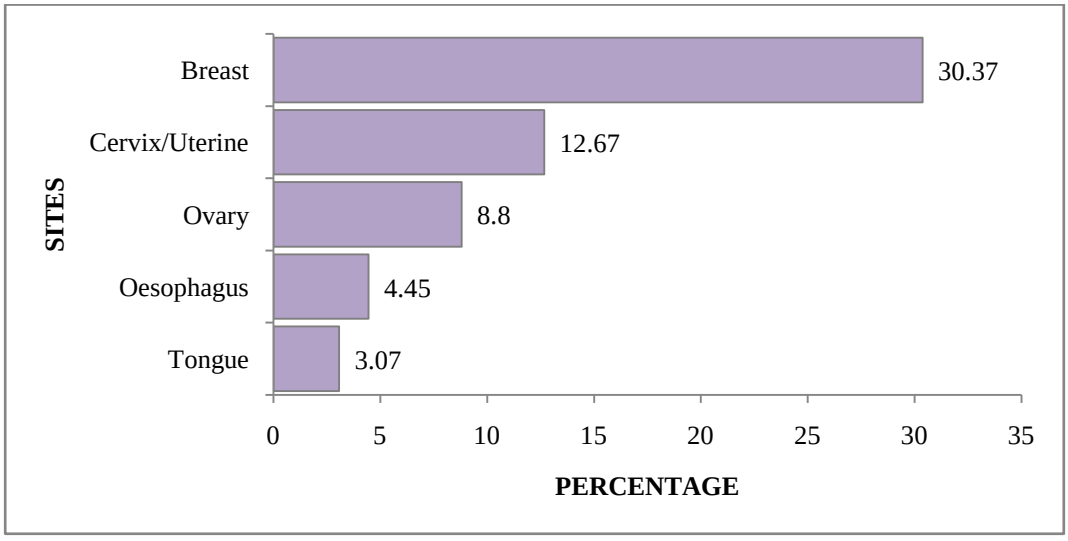


Table 11: Leading sites of cancer observed amongst children of the age-group 0-14 in Ahmedabad during 2008-2010

MALE			FEMALE		
SITES	NUMBER	%	SITES	NUMBER	%
1. Lymphoid Leukaemia	459	54.32	1. Lymphoid Leukaemia	216	40.45
2. Hodgkin's Disease	117	13.84	2. Myeloid Leukaemia/Ovary	118	22.1
3. Myeloid Leukaemia	107	12.66	3. Eye and Adnexa	98	18.35
4. Brain	98	11.6	4. Brain	56	10.49
5. Bones Of Limbs	64	7.58	5. Bones Of Limbs	46	8.61

Figure 14: Leading sites of cancer amongst children of the age-group 0-14 in Ahmadabad during 2008-2010: Male

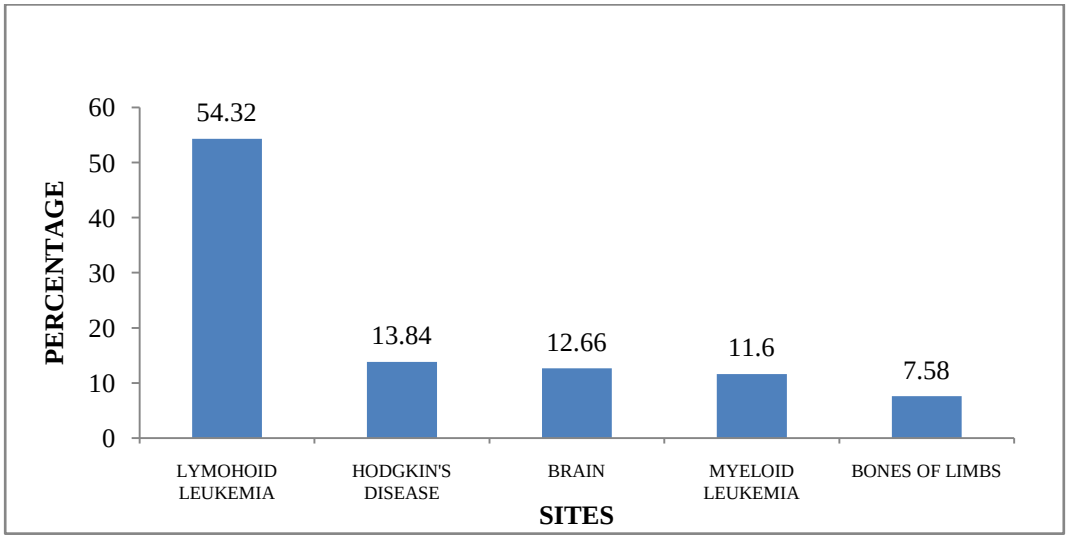


Figure 15: Leading sites of cancer amongst children of the age-group 0-14 in Ahmedabad during 2008-2010: Female

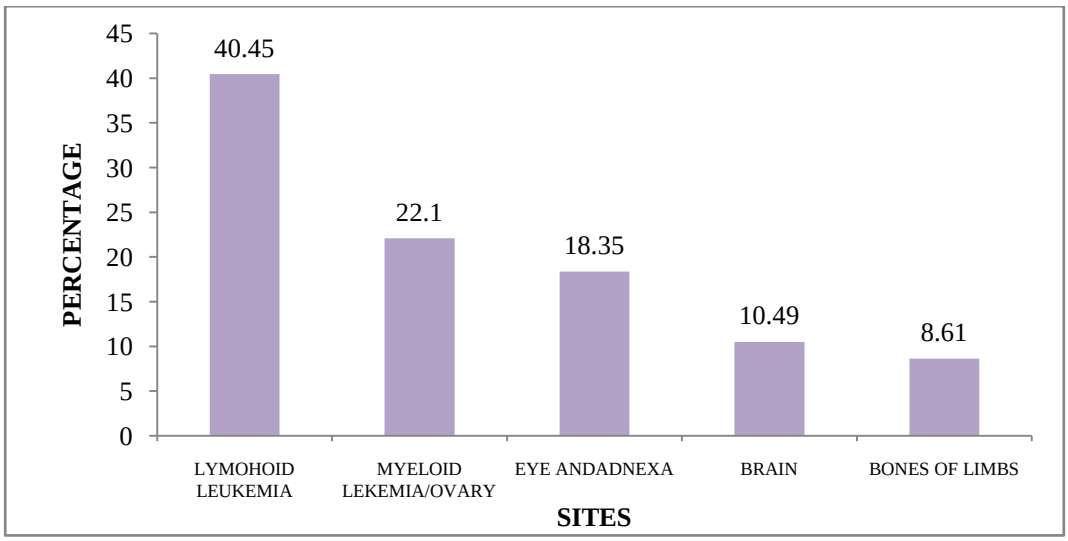


Table 12: Leading sites of cancer amongst various age-groups in Ahmedabad during 2008-2010: Male and Female

MALE					FEMALE				
15-34 Years					**15-34 Years**				
RANK	ICD-10	SITES	NUMBER	%	RANK	ICD-10	SITES	NUMBER	%
1	C-92	Myeloid Leukaemia	836	32.73	1	C-50	Breast	1182	37.05
2	C-06	Other Parts of Mouth	533	20.87	2	C-53	Cervix	900	28.21
3	C-91	Lymphoid Leukaemia	461	18.05	3	C-92	Myeloid Leukaemia	456	14.3
4	C-40	Bone of Limbs	394	15.43	4	C-56	Ovary	349	10.94
5	C-02	Other Parts Of Tongue	330	12.92	5	C-71	Brain	304	9.5
35-64 Years					**35-64 Years**				
RANK	ICD-10	SITES	NUMBER	%	RANK	ICD-10	SITES	NUMBER	%
1	C-34	Bronchus & Lung	2012	32.78	1	C-50	Breast	2125	41.81
2	C-01	Base Of Tongue	1364	22.24	2	C-53	Cervix	1242	24.43
3	C-06	Other Parts of Mouth	1109	18.07	4	C-15	Oesophagus	605	11.91
4	C-15	Oesophagus	859	13.99	3	C-56	Ovary	567	11.15
5	C-12	Pyriform Fossa	793	12.92	5	C-06	Other Parts of Mouth	544	10.7
65+ Years					**65+ Years**				
RANK	ICD-10	SITES	NUMBER	%	RANK	ICD-10	SITES	NUMBER	%
1	C-34	Bronchus and Lung	857	34.31	1	C-50	Breast	750	35.79
2	C-01	Base of Tongue	542	21.7	2	C-53	Cervix	624	29.77
3	C-12	Pyriform Fossa	379	15.17	5	C-34	Bronchus and Lung	289	13.79
4	C-15	Oesophagus	364	14.57	3	C-56	Ovary	277	13.21
5	C-32	Larynx	356	14.25	4	C-15	Oesophagus	156	7.44

Figure 16: Leading sites of cancer amongst various age-groups in Ahmedabad during 2008-2010: Male

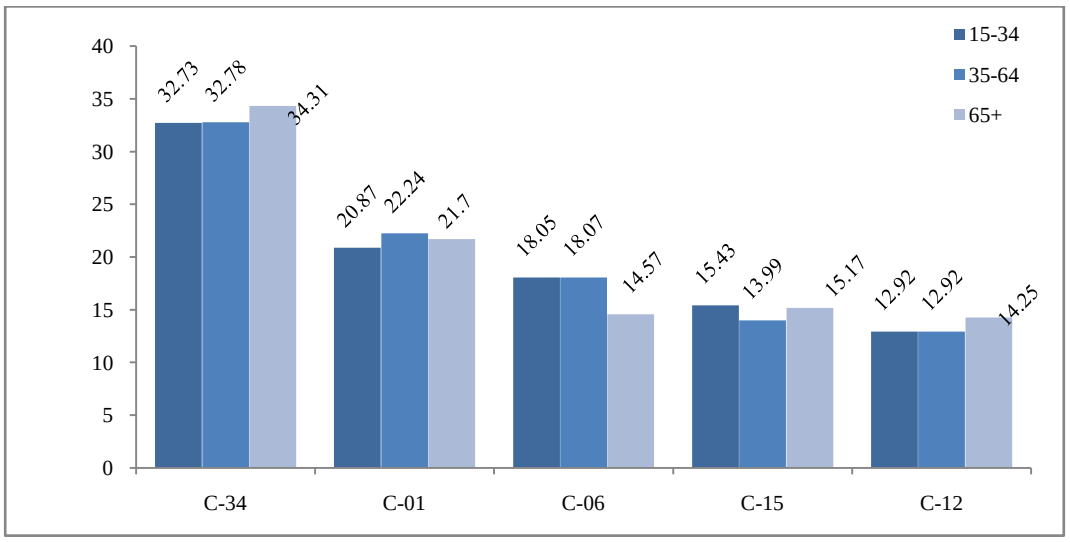


Figure 17: Leading sites of cancer amongst various age-groups in Ahmedabad during 2008-2010: Female

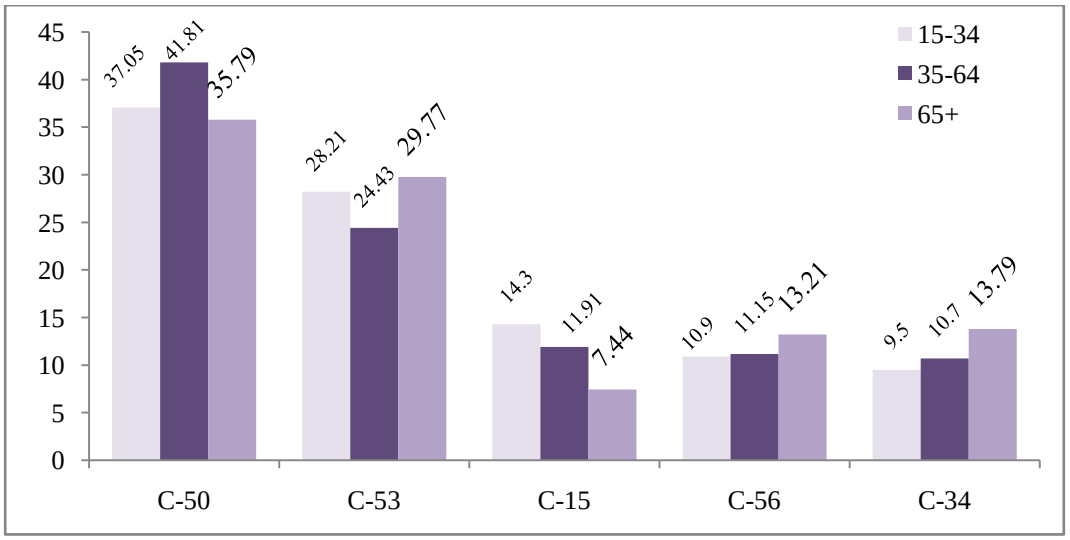


Table 13: The numbers and proportion of tobacco-related cancers in male and female populations analyzed in the current study.

Sites of Cancer	MALE		Sites of cancer	FEMALE	
	Number	Percent		Number	Percent
1. Oral cavity	1383	23.54	1. Oral cavity	323	21.57
2. Tongue	1231	20.96	2. Tongue	280	18.69
3. Lung	976	16.62	3. Lung	247	16.49
4. Larynx	614	10.45	4. Hypopharynx	236	15.11
5. Oesophagus	604	10.28	5. Oesophagus	226	15.78
6. Hypopharynx	373	6.35	6. Larynx	65	4.33
7. Tonsil	264	4.49	7. Tonsil	54	3.62
8. Pharynx	198	3.37	8. Pharynx	26	1.73
9. Urinary bladder	132	2.25	9. Urinary bladder	21	1.42
10. Oropharynx	77	1.31	10. Oropharynx	12	0.79
11. Lip	22	0.37	11. Lip	7	0.47
T.R.C	5874	100	T.R.C	1497	100

Figure 18: Sites of tobacco-related cancer in males

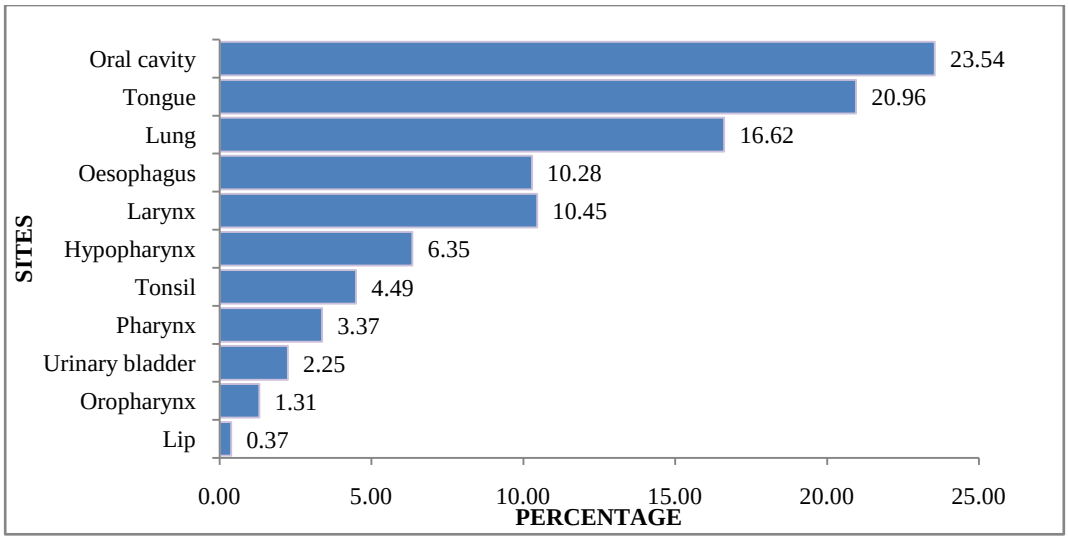


Figure 19: Sites of tobacco-related cancer in females

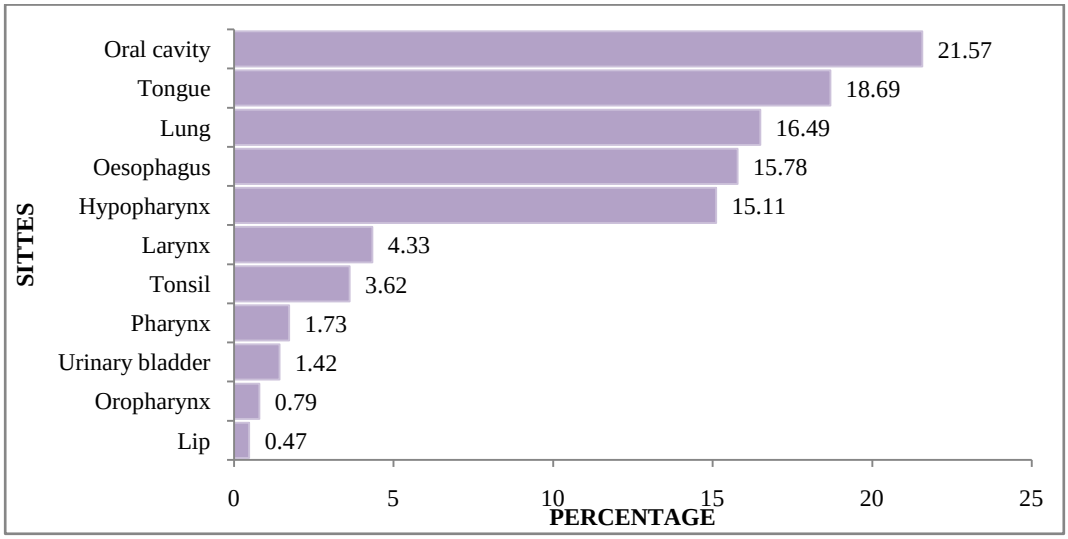


Table 14: The number and percentage of cancer cases detected by method of diagnosis during the span of study in the population evaluated

METHOD OF DIAGNOSIS	MALE		FEMALE		TOTAL	
	Number	%	Number	%	Number	%
MICROSCOPIC	12847	95.58	10899	96.85	23746	96.25
Primary Histology	10130	75.37	8641	76.78	18771	76.09
Secondary Histology	823	6.18	640	5.69	1463	5.93
Cytology	684	5.09	542	4.82	1226	4.97
Bone Marrow	1210	9.00	1076	9.56	2286	9.27
RADIOLOGY	170	1.36	103	0.91	273	1.11
CLINICAL	86	0.68	93	0.83	179	0.73
OTHERS include	92	0.69	54	0.48	146	0.59
Biochemical/immunological,	0	0	0	0	0	0
Endoscopy etc.	0	0	0	0	0	0
DCO	221	1.69	105	0.93	326	1.32
TOTAL	13416	100.00	11254	100	24670	100

Figure 20: A comparison of cases detected through microscopic evaluation versus other methods of cancer detection in the population analysed during the span of study

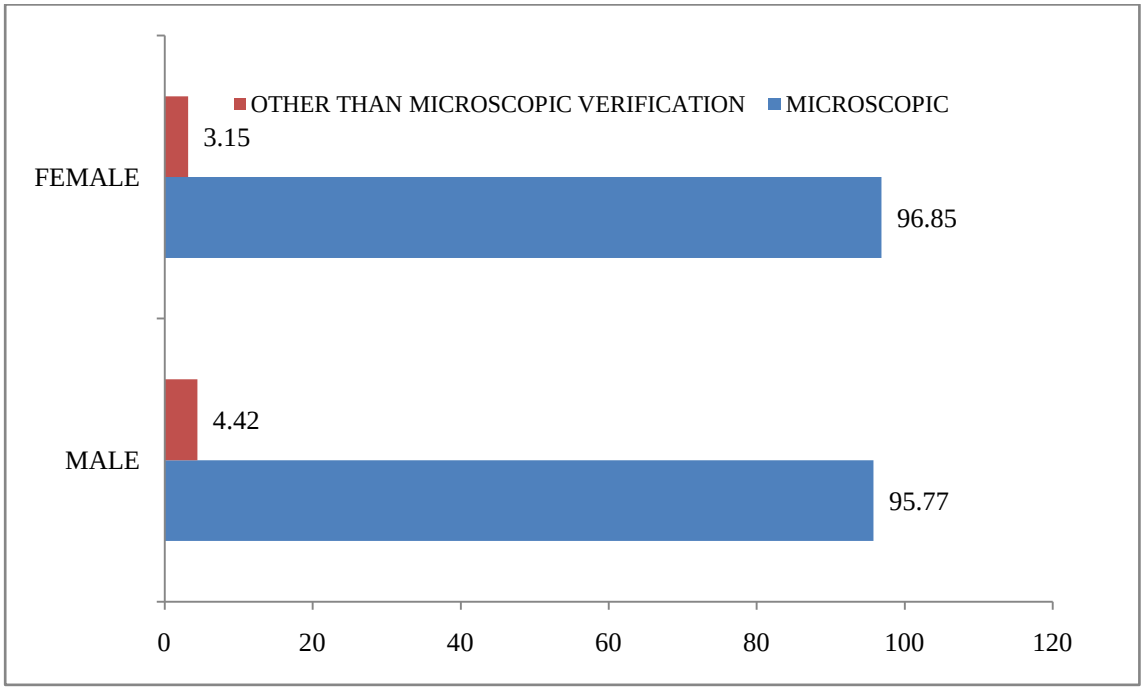


Figure 21: Diagnostic methods used for cancer detection/confirmation: Male

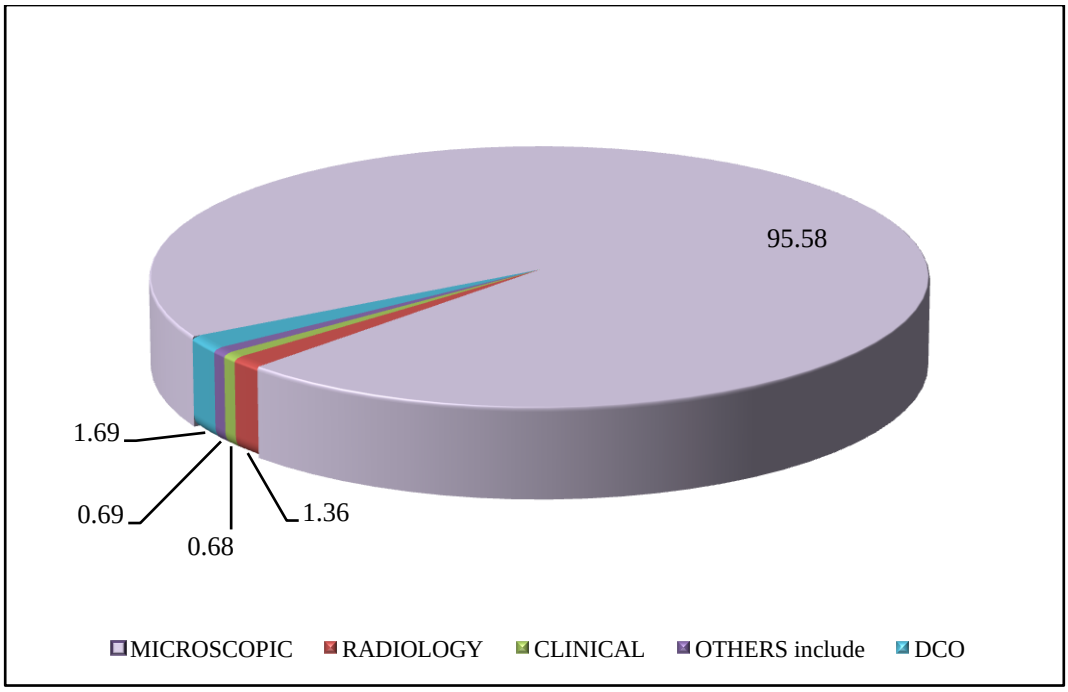


Figure 22: Diagnostic methods used for cancer detection/confirmation: Female

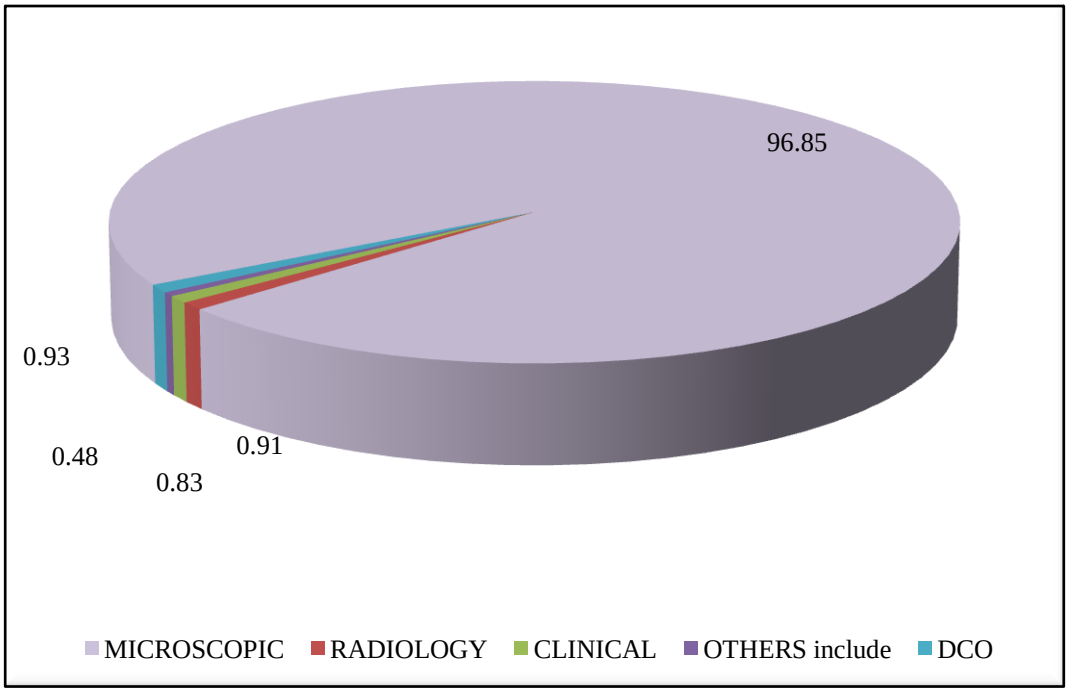


Table 15: Patients approached and treated for cancer at GCRI Ahmedabad during 2008-2010

TREATMENT AT GCRI	MALE		FEMALE		TOTAL	
	Number	%	Number	%	Number	%
Completed	8369	35.64	7853	41.54	16222	38.27
Incomplete	5654	24.08	4175	22.08	9829	23.19
Not received	7895	33.63	5642	29.84	13537	31.94
Not accepted	1562	6.65	1235	6.53	2797	6.60

Table 16: The type of treatment received at GCRI Ahmedabad during the span of study

TYPE OF TREATMENT	MALE		FEMALE		TOTAL	
	Number	%	Number	%	Number	%
SURGERY	1956	13.95	1586	13.19	3542	13.60
RADIO THERAPY	7135	50.88	6565	54.58	13700	52.59
CHEMO THERAPY	4664	33.26	3156	26.24	7820	30.02
HORMONE THERAPY	83	0.59	368	3.06	451	1.73

Figure 23: Record of patients and the type of treatment received at GCRI during the span of study.

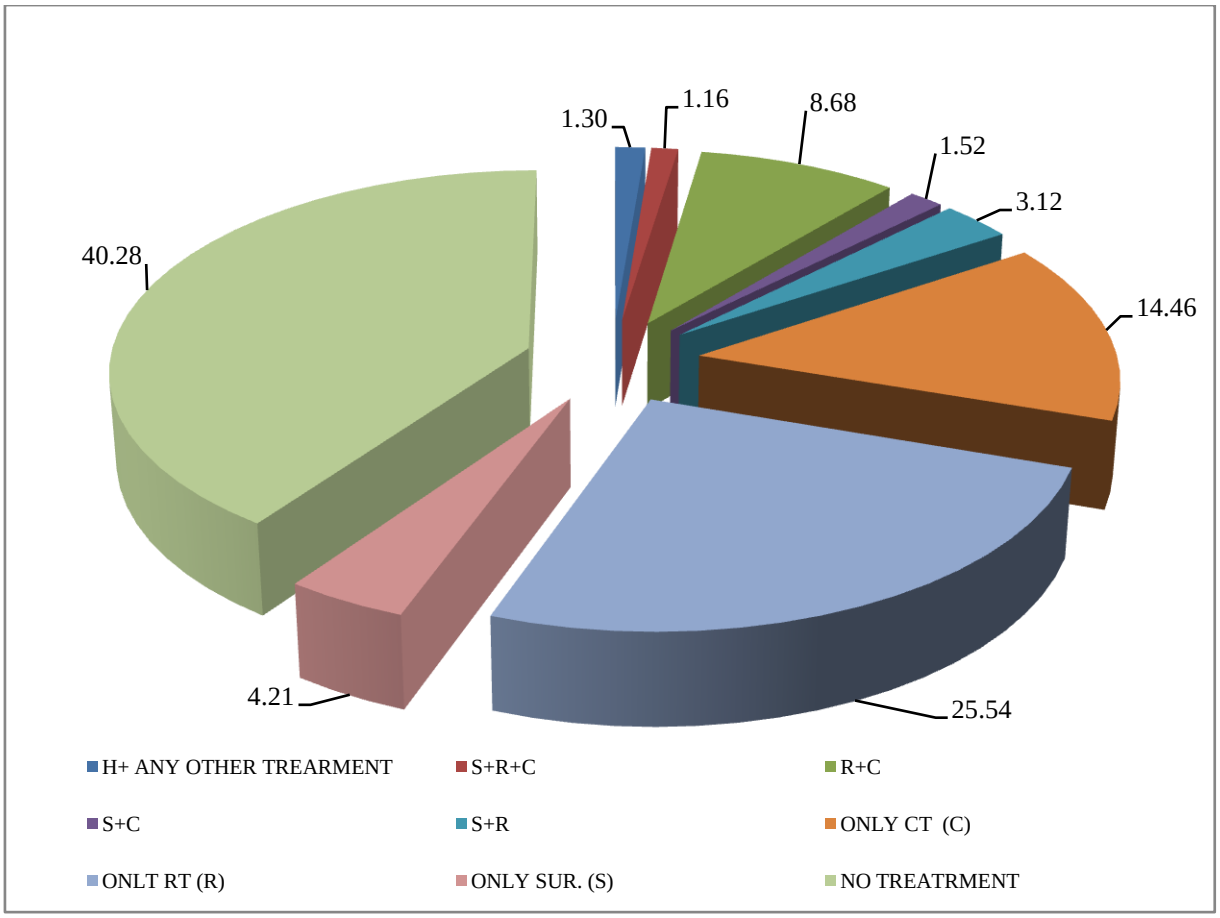


Table 17: Crude Mortality rate (CMR), Age Adjusted mortality rate (AAMR) and Truncated Mortality Rate (TMR) by gender: PBCR-Ahmedabad Urban, 2008-2010.

MALE			FEMALE		
CMR	AAMR	TMR	CMR	AAMR	TMR
26.4	32.65	64.85	18.1	21.3	47.3

Table 18: Number and percentage (%) of cancer deaths with five year age group by gender: PBCR-Ahmedabad Urban 2008-2010

AGE GROUP	MALE		FEMALE	
	Number	%	Number	%
00-04	7	0.82	2	0.44
05-09	5	0.59	4	0.89
10-14	10	1.17	5	1.11
15-19	18	2.1	7	1.56
20-24	38	4.43	8	1.7
25-29	26	3.04	10	2.22
30-34	62	7.24	18	3.99
35-39	78	9.11	38	8.43
40-44	96	11.21	48	10.64
45-49	92	10.75	54	11.98
50-54	115	**13.44**	74	**16.41**
55-59	67	**7.83**	46	**10.21**
60-64	81	9.47	49	**10.87**
65-69	62	7.24	38	**8.43**
70-74	65	7.59	31	6.87
75+	31	3.62	16	3.57
UNKNOWN	3	0.35	3	0.68

Figure 24: Gender specific mortality rates per 100,000 persons: GCRI 2008-2010

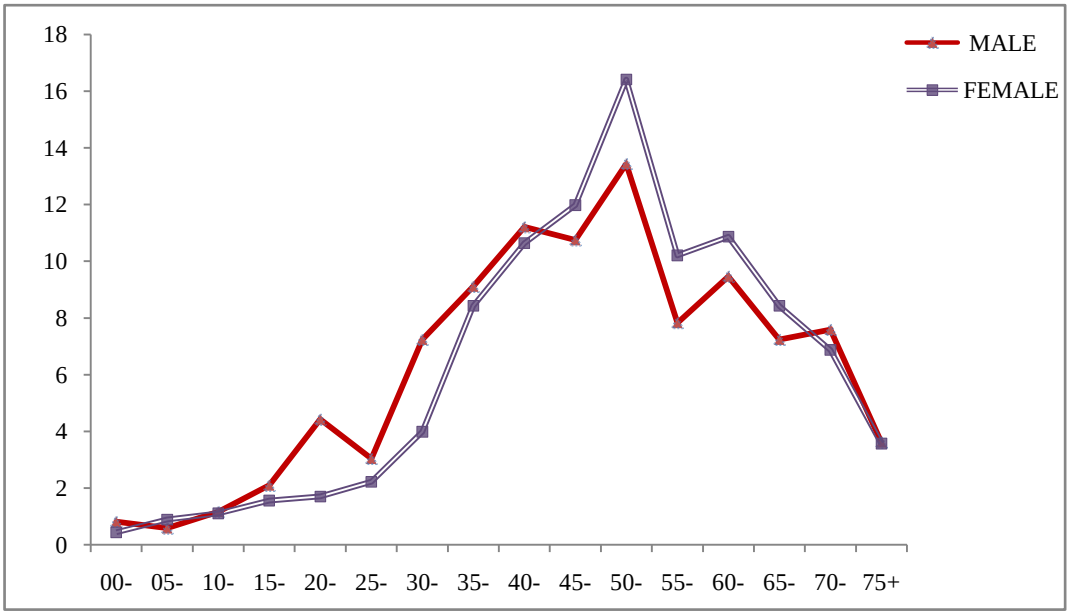


Table 19: Age-specific cancer mortality rates per 100,000 persons with five year age group by gender: PBCR-Ahmedabad 2008-2010

AGE GROUP	MALE	FEMALE	TOTAL
00-04	1.6	0.5	2.1
05-09	1.8	1.9	3.7
10-14	1.9	1.5	3.4
15-19	1.7	2.3	4
20-24	3.5	2.5	6
25-29	6.7	3.1	9.8
30-34	11.9	8.7	20.6
35-39	25.1	16.9	42
40-44	30.2	30.5	60.7
45-49	53.8	38.7	92.5
50-54	73.9	81.6	155.5
55-59	103.8	70.5	174.3
60-64	140.3	72.1	212.4
65-69	135.4	65.8	201.2
70-74	195.2	89	284.2
75+	87.4	51.2	138.6

Figure 25: Age-specific Mortality rates per 100,000 persons: GCRI 2008-2010

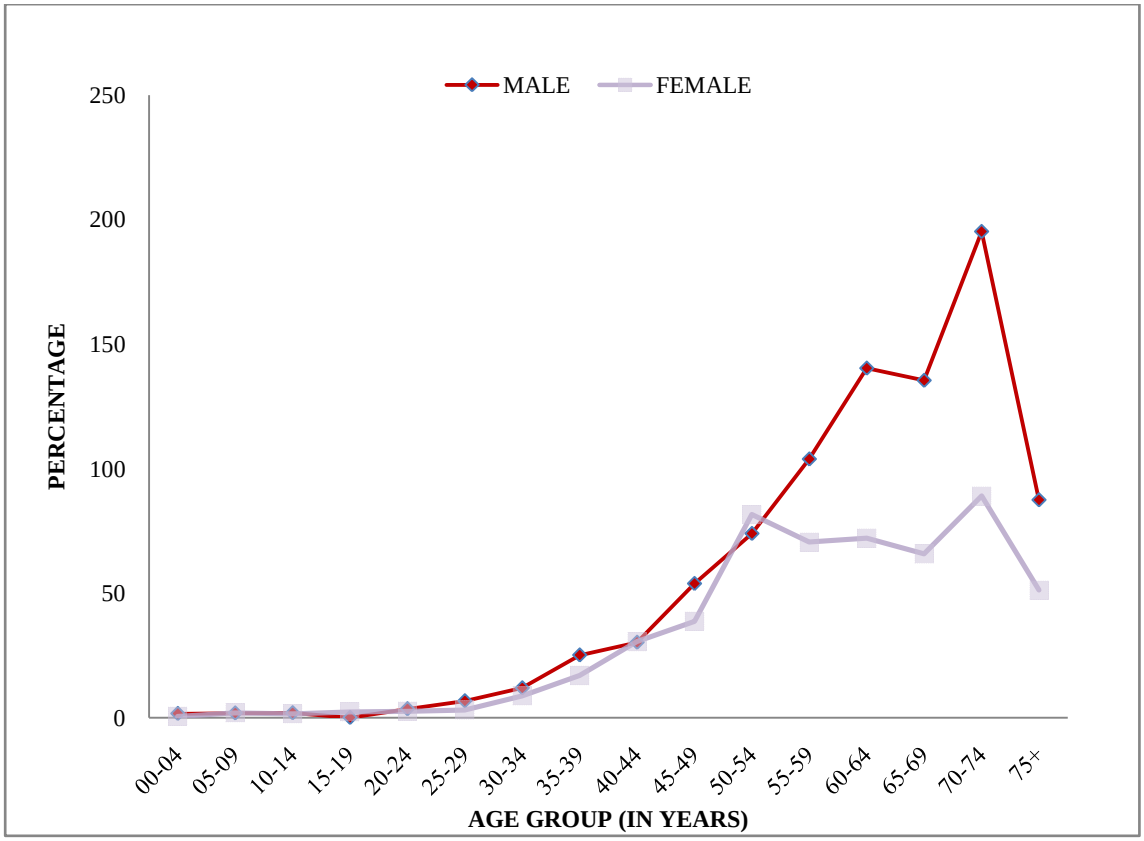


Table 20: Number of Cancer Deaths by five year age-group and site: Male (2008-2010)

ICD-10	Site	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+	Unk	Total	%
C00	Lip	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	0	4	0.47
C01-02	Tongue					2	6	12	8	17	16	13	6	4	1	2			87	10.16
C03-06	Mouth					2	2	9	8	13	20	21	7	9	9	5	6		111	12.97
C07-08	Salivary glands					2						1	1	1					5	0.58
C09	Tonsil							2	3	2	2	3	1	2	3				18	2.10
C10	Oth. Oropharynx								1		2	1	2						6	0.70
C11	Nasopharynx										1		1						2	0.23
C12-13	Hypopharynx					1	1		1	3	3	7	2	9	2	4	1		34	3.97
C14	Pharynx								1	4	2	3	1	4	3	2	1		21	2.45
C15	Oesophagus					2	2	2	3	7	4	3	5	8	2	4	1	1	44	5.14
C16	Stomach					1	2	2			3	4	5	1	2		1		21	2.45
C17	Small intestine					1				2									3	0.35
C18	Colon									3	3	1	3	2	2	1			15	1.75
C19-20	Rectum and anus					2			1		5	1	2	3	3				17	1.99
C19-21	Anus									2	1		2						5	0.58
C22	Liver						2	1	2	3	2	1	8		2				21	2.45
C23-24	Gallbladder						1	2					2	5		2	1		13	1.52
C25	Pancreas										2		1	1		5			9	1.05
C30-31	Nose, sinuses								2				1						3	0.35
C32	Larynx									4	4	3	3	4	2	2			22	2.57
C33-34	Lung							1	2	7	11	8	15	17	16	22	4	2	105	12.27
C37-38	Other Thoracic								1	2					1	1			5	0.58
C40-41	Bone			4	2	1					2	1				3			13	1.52
C43	Melanoma of skin																		0	0
C44	Other Skin																		0	0

ICD-10	Site	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+	Unk	Total	%
C45	Mesothelioma																		0	0
C46	Kaposi Sarcoma																		0	0
C47-49	Soft tissues					2	1												3	0.35
C50	Breast								1					1					2	0.23
C60	Penis											1			1				2	0.23
C61	Prostate										1	2	4	6	9	3	4		29	3.39
C62	Testis	1						1	1	2					1				7	0.82
C63	Other male genital																		0	0
C64	Kidney	1	2							2	2	4	5	3					20	2.34
C65	Renal Pelvis																		0	0
C66	Ureter																		0	0
C67	Bladder							1	2		3	1	2		2	1			12	1.40
C69	Eye																		0	0
C70-72	Brain, central nervous system		2	3	1			3	4		6	1		2	1	2			25	2.92
C73	Thyroid						1							1					2	0.23
C74	Adrenal gland										1								1	0.12
C77	Secondary Lymph Node						1	1	2	1	3	6	2	4	6	6			32	3.74
C78	Sec. Resp. Organ						2			2		3	2	2	4	3		1	19	2.22
C79	Sec. Other sites										2	2	3	1					8	0.93
C81	Hodgkin lymphoma													2					2	0.23
C82-85,C96	NHL				3				3			3	2	4					15	1.75
C90	Multiple myeloma										1	1				2			4	0.47
C91	Lymphoid Leuk.	3	6		2	3	2	4	2						3				28	3.27
C92-94	Myeloid Leuk.		3	3					4	6	4		2	1	2	2			27	3.15
C95	Leukemia Uns.																		0	0
O&U	Others&uns.				2		2	1	2	2	2	7	2	4	2	3	2	3	34	3.97
	All sites	5	13	10	10	19	25	42	54	84	108	103	92	103	80	75	21	7	856	100

Table 21: Number of Cancer Deaths by five year age-group and site: Female (2008-2010)

ICD-10	Site	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+	Unk	Total	%
C00	Lip	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
C01-02	Tongue					0	0	1	2	1	3	2	3	2	0	1	1		16	3.55
C03-06	Mouth					0	0	0	1	1	2	3	3	3	1	1			15	3.33
C07-08	Salivary glands													1					1	0.22
C09	Tonsil							2	2	2	2	3	1	2	3				17	3.77
C10	Oth. Oropharynx											1							1	0.22
C11	Nasopharynx										1		0						1	0.22
C12-13	Hypopharynx							1		2	3	2	1		2	2			13	2.88
C14	Pharynx												1						1	0.22
C15	Oesophagus						2		2		4	2	5	6	2	1			24	5.32
C16	Stomach								2	1	3	2	1			1	2		12	2.66
C17	Small intestine																		0	0.00
C18	Colon												1			1			2	0.44
C19-20	Rectum and anus									1		1	1	1		1			5	1.11
C19-21	Anus										1				1				2	0.44
C22	Liver							1				3	1	2	1				8	1.77
C23-24	Gallbladder						1	2	1	1	3	3		2		1			14	3.10
C25	Pancreas															1			1	0.22
C30-31	Nose, sinuses												1	1		1			3	0.67
C32	Larynx											1							1	0.22
C33-34	Lung								1		1	2	1	2	6	2			15	3.33
C37-38	Other Thoracic																		0	0.00

ICD-10	Site	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+	Unk	Total	%
C40-41	Bone		1	2															3	0.67
C43	Melanoma of skin																		0	0.00
C44	Other Skin														1				1	0.22
C45	Mesothelioma																		0	0.00
C46	Kaposi Sarcoma																		0	0.00
C47-49	Soft tissues	2			1	1			1	1		2							10	2.22
C50	Breast						2	6	15	20	21	20	10	7	6	3	2		112	24.83
C51	Vulva									1						1			2	0.44
C52	Vagina											1					1		2	0.44
C53	Cervix uteri							3	5	8	11	10	8	5	5	6	5		66	14.63
C54	Corpus uteri									1				1					2	0.44
C55	Uterus, other									2	2			1					5	1.11
C56	Ovary etc.					1		2	2	1		2	2	2	1	1			14	3.10
C57	Other Female Organ																		0	0.00
C58	Placenta																		0	0.00
C64	Kidney											1							1	0.22
C65	Renal Pelvis																		0	0.00
C66	Ureter																		0	0.00
C67	Bladder																		0	0.00
C69	Eye																		0	0.00
C70-72	Brain, central nervous system		2						1						1				4	0.89
C73	Thyroid									1					1				2	0.44
C74	Adrenal gland									1									1	0.22
C77	Secondary Lymph Node							1	1		1	2		1	1				7	1.55
C78	Sec. Resp. Organ						1	2	1	2		2	1	3	1	2	1		16	3.55
C79	Sec. Other sites											1	1			1			3	0.67
C81	Hodgkin lymphoma										1				1				2	0.44

ICD-10	Site	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+	Unk	Total	%
C82-85,C96	NHL								1	1	1	1			1		1		6	1.33
C90	Multiple myeloma								1			1			1	1			4	0.89
C91	Lymphoid Leuk.	1	2	2	2	1	1						1						11	2.44
C92-94	Myeloid Leuk.	1	1	2	1	2		1	2			1	1	1	1				15	3.33
C95	Leukemia Uns.		1		1				1				1						4	0.89
O&U	Others&uns.								1		1			2	1		1		6	1.33
	All sites	4	7	6	5	5	7	22	43	48	61	69	45	45	38	28	14	0	451	100

ANNEXURE I: Copy of permission letter

A joint venture of Govt. of Gujarat & Gujarat Cancer Society

THE GUJARAT CANCER & RESEARCH INSTITUTE

[M. P. Shah Cancer Hospital]

REGIONAL CANCER CENTRE

(Recognized by Ministry of Health & Family Welfare, Govt. of India)

No. GCRI/Est/ 17144
January 24 ,2(

To
The Dean
Faculty of Science
Maharaja Sayajirao University of Baroda
Baroda
Gujarat

Sub. : Permission given for using the statistical data of GCRI for Mr. S.N. Saxena only.

Dear Sir,

We are giving the permission for using our GCRI registry data for the use as reference to Mr. S.N. Saxena for his Ph.D. thesis entitled for Epidemiology, Surveillance of cancer cases in relation with Lifestyle, Behaviour and Environmental Factors under Department of Zoology, Faculty of Science "The Maharaja Sayajirao University of Baroda", Baroda – 390 002.

Thanking you,

Yours sincerely,

Dr. Pankaj M. Shah
Hon. Director

Member of UICC
Civil Hospital Campus, Asarwa, Ahmedabad - 380 016. INDIA.
Gram : GUJCANCER Phone : 91 - 79 - 2268 8000. Fax : 91 - 79 - 2268 5490
Email : gcriad1@bsnl.in http:\\www.cancerindia.org

ANNEXURE II: Format of questionnaire

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

DEPARTMENT OF ZOOLOGY

QUESTIONNAIRE

The following information will be used solely for the purpose of research work by Mr. Shambhu Saxena for which permission is obtained from the honourable Director of GCRI vide permission letter No: GCRI/Est/17144. Further, we vouch abide by all the ethical norms and the personal information gathered shall be kept anonymous.

1. Name: _____

2. Sex: M/F

3. Age:

4. Address:

5. Native of Ahmedabad: Y/N

6. Any addictions: Tobacco(chewing/smoking)/Alcohol

7. Duration of addiction:

8. Occupation:_____/Any hazards related to work

9. Registered at:

10. Registration Date:

11. Medical history of patient:

12. Medical history of family(Any relative known to have cancer):

13. Diagnosed for:

PTO

14. Method of Diagnosis:

i. Microscopically- primary histology/secondary histology/cytology

ii. X-ray/image analysis

iii. Clinical/biochemical (enzyme/antibody/hormone/any other)

15. Cancer Stage Detected:

16. Treatment accepted or not: Y/N

17. Treatment type:

a. Surgery(S) **b.** Raditotherapy(RT) **c.** Chemotherapy(CT) **d.** Hormone therapy(HT)

e. Any other

ii. Combination therapy: S+RT/S+CT/RT+CT/S+RT+CT/ANY OTHER

18. Duration of treatment:

19. Cost of treatment:

20. Death during treatment:

Sd/-

Patient/Relative

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