1. Introduction

Cancer is a major global public health problem. It has been estimated that the worldwide burden of cancer has risen to 14.1 million new cases and 8.2 million cancer related deaths in the year 2012 (IARC, 2013). Cancer has been a public health concern in both developed and developing countries (Global Health Estimates, WHO 2013). Chronic diseases such as cardiovascular diseases and cancer place a heavy resource demand on the health system. Premature deaths, ill health, impairment and disability from cancer have resulted in a global economic loss of $895 billion in 2008, which is almost 20 percent higher than heart disease (John and Ross, 2010).

Life expectancy of people in the world has increased and the greatest increase has been observed in the middle income and low income countries, which has resulted in the increase in the burden of non communicable diseases such as CVD’s and cancers (World Health Statistics, 2014). Developing countries are currently undergoing an epidemiological transition in which they now face the “double burden” of infectious disease and chronic diseases such as cancer, heart disease, stroke, chronic respiratory diseases and diabetes (Lopez et al., 2006).

The most predominant cancer type that was diagnosed worldwide include the lung cancer followed by prostate cancer among men and the breast and the cervical cancer among women (GLOBOCAN, 2012) (Figure I and II). Cancer risk factors are more prevalent in low socioeconomic (SES) groups since they are more likely to use tobacco, high fat and energy dense foods and as they are less likely to be physically active, reside in unhealthy living conditions and lack access to health care services and care (WHO, Preventing Chronic Diseases, 2005).

Most researches have indicated that the lack of insurance and other barriers are responsible for the increasing cancer care costs. Many individuals are not able to receive the optimal cancer care until they are at terminal stage of their diseases. In India, people are more
inclined to borrow money and sell their assets during hospitalization and cancer becomes an economic burden on the family (Deogaonkar, 2004).

Figure I Common Cancers among Male Population Worldwide (GLOBOCAN 2012)

Figure II Common Cancers among Female Population Worldwide (GLOBOCAN 2012)

Anderson et al., (2008) recommended that countries with weak health system and limited resources for population based screening require affordable developing cost and feasible approaches to address this problem in high risk population at a given geographical area. Mejia and Braithwaite, (2008) described that existing cancer information systems have significant limitations which include:
i) Only a small portion of the population being covered by cancer registries
ii) Quality of registries and information systems
iii) Accessing rural populations

Hence, information on the trends and pattern of cancer is essential for health planners and policy makers to develop appropriate cancer control programs (Parkin, 2001).

1.1 Burden of Breast Cancer

1.1.1 Global scenario

Breast cancer has been the leading cause of cancer among women in both developed and developing countries (Jemal et al., 2011). In 2012, 1.7 million women were diagnosed with breast cancer and there were 6.3 million women alive who had been diagnosed with breast cancer in the previous five years. Since the 2008 estimates, breast cancer incidence has increased by more than 20%, while mortality has increased by 14%. Breast cancer is also the most common cause of cancer death among women (522 000 deaths in 2012) and the most frequently diagnosed cancer among women in 140 of 184 countries worldwide. It now represents one in four of all cancers in women (GLOBOCAN, 2012). Figure III and IV represent the age standardised breast cancer incidence and mortality rates at the global level.

Figure III Global Age-Standardized Breast Cancer Incidence rates (GLOBOCAN 2012)
Women are at increasing high risk of breast cancer with incidence rates increasing in most countries. International comparison of breast cancer rates by area and time of diagnosis provide important clues to the underlying causes of the disease and the consequence of changing exposures to reproductive and nutrition related determinants over time (Bray et al.,
2004). A fourfold increase in the breast cancer incidences from the year 1980 to 2010 is observed in both developed and developing countries (Figure V).

Table I: Estimated Breast Cancer Incidence, Mortality and Prevalence (Worldwide in 2012)

<table>
<thead>
<tr>
<th>Region</th>
<th>Cases</th>
<th>Deaths</th>
<th>5-year Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>1671</td>
<td>522</td>
<td>6232</td>
</tr>
<tr>
<td>More Developed regions</td>
<td>788</td>
<td>198</td>
<td>3201</td>
</tr>
<tr>
<td>Less developed regions</td>
<td>883</td>
<td>324</td>
<td>3032</td>
</tr>
<tr>
<td>WHO Africa region (AFRO)</td>
<td>100</td>
<td>49</td>
<td>318</td>
</tr>
<tr>
<td>WHO Americas region (PAHO)</td>
<td>408</td>
<td>92</td>
<td>1618</td>
</tr>
<tr>
<td>WHO East Mediterranean region (EMRO)</td>
<td>99</td>
<td>42</td>
<td>348</td>
</tr>
<tr>
<td>WHO Europe region (EURO)</td>
<td>494</td>
<td>143</td>
<td>1936</td>
</tr>
<tr>
<td>WHO South- East Asia region (SEARO)</td>
<td>240</td>
<td>110</td>
<td>735</td>
</tr>
<tr>
<td>WHO Western Pacific Region (WPRO)</td>
<td>330</td>
<td>86</td>
<td>1276</td>
</tr>
<tr>
<td>IARC membership (24 countries)</td>
<td>935</td>
<td>257</td>
<td>3591</td>
</tr>
<tr>
<td>United States of America</td>
<td>233</td>
<td>44</td>
<td>971</td>
</tr>
<tr>
<td>China</td>
<td>287</td>
<td>48</td>
<td>697</td>
</tr>
<tr>
<td>India</td>
<td>145</td>
<td>70</td>
<td>397</td>
</tr>
<tr>
<td>European Union (EU-28)</td>
<td>362</td>
<td>92</td>
<td>1444</td>
</tr>
</tbody>
</table>

Source: [http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx](http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx)

Table I, compares the breast cancer incidences, mortality and 5 year prevalence for different regions of the world. Worldwide increase in breast cancer incidence is quite evident, but there are high inequalities between rich and poor countries. Incidence rates are highest in more developed regions but morality is relatively much higher in less
developed countries due to lack of early detection and access to treatment facilities (WHO-Global Health Estimates, 2013).

1.1.2 Indian scenario

The Population based cancer registries of the major Indian cities including Delhi, Mumbai, Bangalore, Ahmadabad, Calcutta and Trivandrum have reported rising trends of breast cancer incidence and these registries have documented breast cancer as the commonest cancer among women where it constitutes more than 30% of all cancers in females (ICMR Bulletin, 2010 and NCRP-ICMR, 2013(a). Due to community awareness programs and cancer screening clinics, burden of cervical cancer has shown decreasing patterns in rural areas and the magnitude of breast cancer have increased (ICMR Bulletin, 2010; Jayant et al., 2010).

Murthy et al., (2007) observed that incidence of breast cancer has been consistently increasing and it is estimated that it has risen by 50% between 1965 and 1985. Rise in incidence of 0.5 to 2% per annum has been seen across all regions of India and in all age groups but more so in younger age groups (< 45 years). In India, burden of breast cancer and cervical cancer in North Eastern States constitute around 25%, whereas in all other states these two cancers contributed 35.2 to 57.7% of the total cancers (NCRP-ICMR, 2006). Several authors (Murthy et al., 2007; Takiar et al., 2008; Yeole, 2008; Dhillion et al., 2011); have indicated rising trends in breast cancer incidence and declining trends of cervical cancer in India.

In India, according to the GLOBOCAN (2012) estimates, incidence of female breast cancer is 25.8 per 1,00,000 population, mortality of female breast cancer is 12.7 per 1,00,000 population and 5 year prevalence rate of female breast cancer is 92.6 per 1,00,000 population. Breast Cancer management is heterogeneous in character and requires multi-disciplinary approach. The information on the epidemiology of breast cancer in India is very limited except for few reports. There is no central cancer registry to provide comprehensive nationwide data. The existing cancer registries in India represent less than 5% of the total Indian population and are predominantly from urban areas and majority of the rural areas remain uncovered (Sandhu et al., 2010).

1.2 Mortality-Incidence ratios (MI Ratios) of breast cancer
A systematic analysis of breast cancer incidence and mortality between 1980 and 2010 from 187 countries revealed pronounced differences between developed and developing regions in the Mortality-Incidence Ratios (MI ratios) for breast cancer. Since the mid 1980’s, MI ratios have substantially decreased in both developed and developing countries which coincides with the wider use of screening and introduction of tamoxifen and raloxifene for the treatment of breast cancer. Breast cancer MI ratio increases from less than 0.2 in women younger than 50 years in developed countries to more than 0.35 in women aged 70 years in developing countries (Forouzanfar et al., 2011).

An interaction between genes and the known individual risk factors to some extent explain the divergent trends. Furthermore, time trends seem to be different within same country for different age groups. The complex epidemiological pattern draws attention to the importance of building better surveillance systems. A clear need exists to expand the number of high quality population based cancer registries in low-income countries. The study also highlighted that verbal autopsy methods have created an opportunity for monitoring of breast cancer for countries without complete vital registration systems and medical certification of causes of death. The mobile application for verbal autopsy needs to be strengthened to capture breast cancer and cervical cancer mortality and should be incorporated into existing national programs that monitor maternal deaths (Forouzanfar et al., 2011).

An urgent need in cancer control is called for, to develop effective and affordable approaches to the early detection, diagnosis and treatment of breast cancer among women living in less developed countries, for which local and regional estimates are essential. Risk approach need to be applied where in risk areas and risk groups at local /regional levels are identified and targeted.

1.3 Brief Description about Breast Cancer
   i) Breast lumps and staging of Breast Cancer

   Breast lumps or tumours are broadly classified as benign and malignant. Lumps of the breast that occur due to abnormal fibrosis or cystic changes are benign. Whereas, abnormal growths arising from the cells of the epithelial layer lining the ducts or lobules of the breast are carcinomas which could be either ductal or lobular carcinomas (Kumar et al., 2014).
When cancerous cells are confined to the layers of the ducts or lobules are called as carcinoma–in–situ. At this stage the cells have not grown into (invaded) deeper tissues of the breast or spread to other organs in the body. Diagnosis of breast cancer at this early stage has a good prognosis and higher survival rates (Bradley et al., 2002).

Based on the features of the primary tumour (localization, size and extension to the adjoining structures), regional lymph nodes and the dissemination of cancer as metastasis, a classification system of breast cancer is proposed. Based on this concept, Union of International Cancer Centre (UICC) and American Joint Committee on Cancer (AJCC) currently proposed the TNM system (Tumor, Node and Metastasis) which combines both the clinical and pathologic staging of breast cancer (Harris, 1996; Singletary and Connolly, 2006; Edge and Compton, 2010). Detailed TNM Staging of breast cancer is presented in Appendix I.

Stage of cancer at first clinical presentation helps to group patients and to determine the treatment algorithm and prognosis (Harris, 1996 and Ozsaran et al., 2013). Factors like availability, accessibility and affordability to breast cancer care or treatment services are known to influence the stage of cancer at first clinical presentation and its outcome (Desantis et al., 2012).

**ii) Causes of Breast Cancer**

Cancer is caused by both external factors (chemicals, tobacco, radiation, and infectious organisms) and internal factors (inherited mutations, hormones, immune conditions, and mutations that occur from metabolism). These causal factors may act together or in sequence to initiate or promote carcinogenesis. The development of most cancers requires multiple steps that occur over many years. Certain types of cancer can be prevented by eliminating exposure to those factors that initiate or accelerate this process (URL-1).

During the last four to five decades, health care systems and clinical practice including cancer care have advanced considerably. In order to advance in cancer control research, the optimal approach would be an integration of the study of biological nature of cancer, its clinical implications with behavioural and social influences on the individual and community. Hiatt and Breen presented a ‘transdisciplinary’ framework for breast cancer care and the same is illustrated in Figure VI.
In this framework, Hiatt and Breen presented breast cancer care as a continuum on the horizontal axis with different phases of life from pre-disease to breast cancer mortality. Each phase is influenced by social and environmental factors. Accordingly, disparities and burden of cancer may be reduced by introduction of intervention at any of these levels which would revolve around the social factors (Hiatt and Breen, 2008).

1.4 Risk Factors of Breast Cancer

Despite the billions of dollars and decades spent on breast cancer research, there exists a tremendous gap in understanding the causes and risk factors of breast cancer. The risk factors of breast cancer (Institute of Medicine, 2012) are broadly divided into
i) Familial/ Hereditary factors and
ii) Environmental (Non Hereditary)

The term environmental is used for all non–hereditary factors that are involved in the occurrence of breast cancer including dietary factors, exposures to chemicals, industrialization, agricultural processes, ionizing radiation, occupational stress, physical activity, exposure to tobacco and alcohol. Only 5% of the breast cancers are attributed to hereditary factors and nearly 30% are attributed to environmental exposures, but the cause of breast cancer is not known.

1.4.1 Familial Breast cancer syndromes

Approximately, 15% of healthy women have at least one first degree relative with breast cancer and empirical data shows that breast cancer risk doubles in such women. Germ line BRCA1 or BRCA2 mutations, account for 20-40% of breast cancer that clusters in families associated with a high lifetime risk up to 60-85% for breast cancer as well as an increased risk for ovarian cancer. In addition to this high risk in hereditary breast and ovarian cancer, there are certain heritable syndromes associated with an increased breast cancer risk. In addition several rare cancer predisposing syndromes are associated with breast cancer. Such as Li-Fraumeni syndrome, Peutz Jeghers syndrome and Cowen Syndrome have higher risk of breast cancer (Malone et al., 2010).

1.4.2 Environmental risk factors

Environmental risk factors for breast cancer includes the individuals lifetime exposure to reproductive factors/choices (Persistently high levels of estrogens increases the risk of breast cancer) like early menarche, late menopause, age at first pregnancy, number of pregnancies, child bearing factors, breast feeding, hormonal therapies and endocrine disruptors which have an association with breast cancer (Yager and Davidson, 2006); dietary exposures (alcohol, fat intake, MUFA and PUFA intake, phytoestrogens, calcium and Vitamin D intake, intake of fruits and vegetables), factors in physical environment (like Xenoestrogens, Aromatic Amines, Bisphenol A, Polycyclic Aromatic Hydrocarbons, Vinyl Chlorides, DDT, Ethylene oxide, Lead, Dioxins etc).
NBOCC (2009) and Institute of Medicine (2012), reports that presently more than 85,000 carcinogenic chemicals have been identified in the environment and their prolonged exposure is related to the occurrence of breast cancer. Racial and socio-economic factors predominantly determine the influence of all the above mentioned factors.

1.4.3 Social inequalities as a risk for breast cancer

Just as the environmental risk factors of breast cancers are ignored, so have the complex issues of social inequalities-political, economic and racial injustices. The extent and type of risk factor we are exposed to depend on where we live and work. Poorer communities in both urban and rural shoulder an unequal share of the burden of exposure to toxic material. Social determinants of breast cancer are more likely to contribute to the development and mortality of the disease and these involuntary factors are shown to be of greater impact on low-income women, since these populations are at greater risk of exposure to toxins and social injustice related stresses. Women belonging to the lower income group are also less likely to afford or to get access to healthy foods and quality health care.

Compelling research tells us that true reduction of breast cancer incidence and mortality requires better understanding of the complex tangle of the environmental, social, genetic and behavioural factors.

1.5 Spatial Analysis in Health Services

If the health data is available at one source, the health cycle needs more effective interventions and more applications linking the social determinants of public health. That quest will need the help of better visualizing and analytic tools, such as Geographic Information System (GIS) to convince policy makers. Geographic Information System (GIS) is an information system for capturing, storing, analyzing, managing and presenting spatially referenced data (linked to location). Several initiatives are presently underway across the country to undertake GIS mapping in the health sector. Geographic system in health encompasses the design, development, and utilization of GIS tools for the description of health situations, epidemiological analyses and public health management. Some of its main applications are spatial description/analysis of health events, public health surveillance, health situation analysis
in a given area and target population, analysis of health patterns/differences at various levels, accessibility to health service, and planning and programming of health services.

The visualization and spatial analysis in healthcare sector has been known since 1854, when an English physician, John Snow, created maps with the classic example of how geography can be used in epidemiological research. He identified the water source responsible for an outbreak of cholera in London by mapping the locations of those affected. In 1840, Robert Cowan in Glasgow-England, used maps to show relationship between crowd and incidence of yellow fever. He recognised that incidence of yellow fever was due to immigration. In 1843, he also mapped the incidence of typhus on a map which involved the entire infected house (Mesgari and Masoomi, 2008).

GIS technology offers many advantages in data integration, interactive querying of databases and presentation of findings in the form of maps. Both the visual impact and the data analysis provided by GISs are advantages that support their use. The ability to overlay data layers allows for interpretation beyond that seen with traditional research and statistical methods. The studies reviewed used GISs to both empirically measure and visually identify and explore spatial relationships of health and health variables. GIS use was effective in the investigation of various aspects of healthcare access and health outcomes and therefore can be an asset in the understanding and resolving of health disparities (Johnson and Johnson, 2001).

Most public health care delivery issues including cancer care services facing the world exist in a geographic context and any analysis must consider this aspect. Understanding issues of cancer epidemiology for cancer care provision and access requires a comprehensive understanding of their geography. For this reason, Geographic Information System (GIS) has been used as an excellent means for data storage, integration, visualization and analysis of cancer data, revealing trends, dependencies and inter-relationships. Apart from generating thematic maps that depict the intensity of a disease, GIS allows interactive queries of information contained within the maps, tables or graphs. It provides a dynamic link between databases and maps so that data updates are automatically reflected on maps (Goodchild et al., 1992; Anselin et al., 2006).
Using map-based techniques enables officials to educate the public and policy makers easily and effectively by conveying complex information in a more understandable format (Kraak and Ormeling, 1996; Jerrett et al., 2003). In spatial disease mapping, the primary goals are typically to investigate the connections between the disease and covariates, to characterize the spatial variation of the disease occurrence, and to identify areas having elevated disease risk.

GIS has revolutionized the way researchers explore the geography of health (Gatrell, 1995; Gatrell and Senior, 1999; Melnick, 2002; Ricketts, 2003), and their utility for the study of health issues is widely documented (Scholten and De Lepper, 1991; De Lepper et al., 1995; De Savigny and Wijeyaratne, 1995). GIS and health research focuses on the quantitative analysis of health-related phenomena in spatial settings (Gatrell and Senior, 1999) and, thus, isolates locations of health-related issues for analysis and interpretation.

Disease mapping is an important tool for medical geographers. Such maps help to identify associations between disease and related factors such as environmental pollution. Inevitably, disease maps stimulate the formation of causal hypothesis by enabling the simultaneous examination of multiple factors associated with disease linked by location. Rushton (1999); Elliot et al. (2000) has applied medical geography as a tool for disease mapping and geographical correlation studies to health-related issues. Geographic studies of cancer incidence can provide important guidance for disease control and prevention practices by highlighting high risk communities in need of enhanced interventions.

Bailey and Gatrell, (1995) proposed the analyses of spatial data be divided into three major groups

- Mapping and Visualization
- Exploratory analysis for assessing relationships
- Spatial statistical methods

Visual analysis techniques strengthened with exploratory analysis has mostly been sufficient for epidemiologists, but quantitative modelling of disease distribution is needed to test certain hypothesis or to estimate the relationship between the measure of disease incidence and the environmental covariates. GIS can be useful in generating data for input
into epidemiological models in displaying the results of statistical analysis and modelling processes that occur over space (Clarke et al., 1996).

An important issue in geographical epidemiology is to detect clusters and in this regard conventional work has been carried out by Openshaw and co-workers (1987), Besag and Newell (1991), Rushton and Lolonis (1996). However, these techniques cannot be used to determine if areas with elevated risks are statistically correlated and significant or not. These problems and related statistical issues have led to sophisticated innovations of statistical procedures which may be divided into point-based and area-based methods.

Point based methods require exact locations of individual occurrences whereas area-based methods use aggregated disease rates in regions. Point based methods include Cuzick and Edward’s test (1990), Turnbull’s test (1990), Grimson’s test (1991) and Kulldorff and Nagarwalla’s test (1995). Area based method include Kernel density estimation, Moron’s $I$ (Cliff and Ord, 1973) to detect global clustering (Anselin, 1995). Local clusters can be captured by Local Indicator of Spatial Association (LISA). Other statistics such as Geary’s $C$ (Cliff and Ord, 1973), local Geary and G-statistic (Getis and Ord, 1992) are used to detect global or local clusters. With limited number of events or small population, Bayesian methods permit borrowing information from neighbouring or nearby locations (Mollie, 1996).

The power and versatility of GIS and its application are seen in various health studies. New York State’s Cancer Mapping Project, 2001 adopted the simulated SIRs (likelihood statistic) for each ZIP code and mapped cancer cases for the identification of unusual cancer elevation in New York. Cape Cod Breast Cancer and environment Study was conducted to model the environmental historical exposure to pesticides and other chemicals by using the spatial proximity GIS tool (Kennedy et al., 2003). Bonyah et al., (2013) adopted area to point kriging technique to identify breast cancer incidence cluster in women above 40 years and below 40 years in Ashanthi region. Land Use patterns and proximity to major roads and exposure to industrial pollution was used to compare between self reported and GIS based proxies of residential exposure to environmental pollution for a case control study on Lung Cancer (Cardioli et al., 2014). Bayesian spatial Hierarchical analysis was performed by Hsieh et al., (2014) to investigate the impact of spatial location on the effectiveness of
population based breast cancer screening in reducing cancer mortality to other detection methods among Queensland women. California Breast Cancer Mapping: Identifying areas of Concern (2014) project was developed to assess the degree to which biomarkers correlate with GIS derived measures of exposures and in risk assessment.


Cramb et al., (2011) emphasised that GIS are useful tool for assessing and quantifying geographical inequalities and assist to focus research efforts in investigating the observed inequalities. Developing these cancer atlases using GIS could be applied in disease mapping including communicating spatial results, for development and use of statistical results, for development and use of statistical models linked with GIS to investigate the impact of rurality, area level and individual level socio-economic status as well as temporal changes. Research in areas of investigating the reasons for underlying disparities could be used for advocacy, policy making, support and education programs.

Further recent research has been attributed to several combinations of statistical and geo-statistical models. Bonner et al., (2005) has used GIS modelling to reconstruct historical
exposure to environmental pollutants and examined spatial and temporal clustering of Breast cancer cases in Western New York. To evaluate time trends and to explore spatio temporal patterns of prostate cancer Mather et al., (2006) used Hierarchical General Linear Model and Bayesian methods. Bambhroliya et al., (2012) used spatial analysis with Poisson, Bernoulli and multinomial models to detect high risk areas of breast cancer to examine how racial and ethnic differences exist at county levels in Texas.

Spatio-temporal analysis of the breast cancer data may help identify new exposure hypotheses that warrant future epidemiologic investigations with detailed exposure models. The current analyses illustrate the usefulness of Spatial-temporal analysis in GIS to visualize cancer risk, adjust for known confounders, and test for the statistical significance of location and time. This method is particularly useful if detailed, residential histories are available. While our findings are not explanatory, they do identify areas at higher risk and thus can support generation of hypotheses for research and eventual intervention.

Temporal analysis has focused primarily on the detection of cluster and occurrence of diseases at particular periods (Watier et al., 1991; Nobre and Stroup, 1994; Nobre and Carvalho, 1995; Valarmathi et al., 2008; Papoila et al., 2014). In the study of time series, the spatio-temporal analysis was applied to observe spatial patterns of health problems like breast cancer based on modeling and simulation. Modeling the spatial variation allows the study of the disease diffusion process. Here, the estimation of linear spatial transfer functions are used to transform a map at time “t” into that at time, t+1’ and to identify the time trend of incidence rates as to whether the additional cases come predominantly from areas that always have the high incidence or whether they originate from areas of low incidence and move to other areas (Marshall, 1991). Spatio-temporal methods can detect the geographic or temporal breast cancer mortality for the specific study area. This method pinpoints the geographic location, temporal duration, relative risk and statistical significance of the identified clusters. Hsu et al. (2007) have studied the surveillance of prostate cancer disparity in sub-groups of Texas (USA) population using spatiotemporal method and concluded that the uneven geographic distribution of cancer mortality underlines the importance of developing a more data driven model. It seeks to clarify whether the spatio-temporal trend might place an uneven burden and whether the excess trend has persisted into the current decade.
In most geographical research the spatial and temporal dimensions are inseparable. Cluster alarm is not only related to specific area, but it is also claimed to be present during a limited time period. The key to understand many of the elementary geographical concepts is based on the identification, description and analysis of spatio-temporal processes. Knox and Bartlett (1964) developed the first technique to identify spatio-temporal clustering of disease events and applied this method to data on cases of childhood leukemia in northeast England, finding significant evidence of space time clustering. Other methods such as $k$ nearest neighbor test by Jacquez (1996), Mantel test by Mantel (1967) and space-time $k$ function by Diggle et al., (1995) have been proposed for space-time clustering. Space-Time Scan Statistic was developed by Kulldorff and Nagarwalla (1995) based on a Bernoulli model to detect clusters of leukemia cases in New York, USA. Kulldorff et al. (1997) implemented ScaTScan, a cluster detection program which searches for clusters in datasets using two different probabilistic models.

Worldwide variation in cancer incidence has been extensively reported in “Cancer Incidence in Five Continents” (Bray et al., 2004). Earlier variation was reported due to genetics, and the past few years have seen major advances in the understanding of the genetic and molecular basis of the diseases. However, the majority of the variation is a result of social, economic, cultural and environmental differences between populations and describing variations in cancer rates between countries has served to provide clues to specific aetiological factors involved. Variations in cancer risk and aetiological factors between countries are often large and readily amenable to study, but the study of the much smaller range of geographical variations within countries is more challenging like our present study area. Moreover, providing insights which are of local significance is more important. Although current cancer patterns reflect past patterns of exposure to risk factors, taking steps now to deal with these factors in the population has the potential to bring about reductions in future cancer incidence and mortality.

Sometimes merely drawing attention to variation can influence behaviour at both official and individual level to reduce cancer risk. Geographical variations in cancer incidence and the mortality and survival (Kogevinas et al., 1997; Coleman et al., 2004) has been closely
linked to patterns of Socio-Economic status and deprivation. Identification of these patterns can draw attention to the wider dimensions of health which needs to be addressed in order to reduce cancer morbidity and mortality.

The advancements of technology in medical approaches, diagnosis and treatment for the survival of the patients and for detecting the risk of cancer largely at a regional or local scale are increasing day by day. However investigators face several challenges in determining the population at risk, to identify whether a greater than expected numbers of cancer cases represent a particular population. For this, the types of cancer, its stage and the primary diagnostic methods are assessed. So understanding the cancer types and the causative factor is a prime challenge. Then ascertaining the number of cases in suspected population and reporting them correctly is another one.

An important aspect in confirming the cancer cluster is dependent on the group of people who should be considered as the population at risk for a particular/ specific cancer. Determining the statistical significance of the cases who have developed the disease and the association of socio-economic, environmental and exposure details is important. It is necessary to keep in mind that even a statistically significant difference between actual and expected number of cases can arise by chance also. Also investigations must include the tendency of cancer to expand geographically. The rate of expansion should also be attributed to determining cases so as to confirm the exposure or risk or both. Presently, researches are being focussed on one of the above challenges or a combination of them. The use of GIS technology, socio-economic relevance and the integration of spatial statistical tools is a greater task which has to be employed to address such disease challenges.

In our study, we have presented an approach to corroborate GIS techniques and the spatial statistics to understand Breast Cancer in the study area at a localised level. The approaches and the derived outcomes are presented in the forthcoming sections to bring out potential assistance to decision makers and planners.