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Mapping Disease: Deciphering Geographic Patterns of Breast Cancer risk Areas in the Western region of Tamil Nadu, India

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Abstract- Cancer is second largest non-communicable disease and it has a large contribution in the total number of deaths. It is important for the public health professionals to understand the dynamics of cancer incidence for future strategies. Epidemiological Maps describe the Geographical distribution of the disease and the identification of the high risk areas. These maps are useful in resource allocation of policies and health decision making (Assuncao *et al*., 2001) .Therefore, this paper is attempted with the objective of understanding the distribution of breast cancer in Western Region of Tamil Nadu, using Thematic Maps. The data for the present study was collected from the records of NCRP, as well as the concerned private hospitals. The population density was calculated for each taluk and the incidences based on population density were calculated and attributed. Based on this, Using thematic maps the taluks were categorized into high incidences, moderate incidences and low incidences. All the analyses were performed using ArcGIS 9.1 (ESRI). From the observations, it is clear that the breast cancer incidence in the Western region of Tamil Nadu was found to be varying from one area to another, with high incidences in Coimbatore North and South taluks.

Index Terms- Breast Cancer, Epidemiological Maps, ArcGIS

I. INTRODUCTION

Maps depicting the geographic variation in cancer mortality or treatment can be useful tools for developing cancer control and prevention programs (Kulldorff *et al.*, 2006). Epidemiologically, breast cancer occupies a unique position in the field of oncology. ICMR has suggested that the early detection and prognosis of breast cancer through the training and awareness programs by the medical officers for developing a strategy for its control in India. Medical Geography is the interconnection of medical and geographic knowledge in analyzing the impact of the geographical environment on disease outbreak and spread. Medical Geography with GIS is extremely useful for decision making in epidemiological surveillance programs. Health researchers need improved tools and analysis methods for examining health related information (Hubner and Oliveira, 2004), as the disease alters itself according to the localized environment.

Epidemiologists have traditionally used maps for analyzing the relationships between location, environment and the disease. GIS is a powerful analytical tool to integrate data from many sources and provide knowledge about the relationship between disease and other factors. This tool can be used to prepare maps and develop strategies to combat the deadly outbreak of diseases. Kennedy and Brody (2003) stated that GIS allows the researcher to integrate different layers of spatial information, and describe or quantify the spatial and temporal relationships. Hubner and Oliveira (2004) described that GIS is used to evaluate and illustrate the correlation between breast cancer occurrences and potential environmental factors using thematic map. Maps can be represented as dot-density, proportional circles, spheres, grey-scale (chloropleth) maps, contours (isopleth maps), cartograms and 3D surface plots (Cliff and Haggett, 1988). Geographic patterns of diseases provide insight into incidence and mortality locations and help to identify environmental sources of risk (Ross, 2003). McManus (2005) stated that the thematic map displays the spatial pattern of a theme or series of related attributes. On a general comparison, reference maps show many geographic features (forests, roads, and political boundaries) but thematic maps emphasize spatial variation of one or a small number of geographic distributions using ranges of colours. These distributions may be physical processes (climate), or demographic pattern (population density, socio-economic status and health status) displaying, intensity, location, distribution and pattern at the same time. The three primary purposes of thematic maps as stated by Briney (2009) is that they provide specific information about particular locations, spatial patterns and they can be used to compare patterns on two or more maps.

According to epidemiological studies, the physical environment (water, earth and air), the occupational environment (chemical industries and alike), the dietary environment (food and medicine) and the social and cultural environment (life styles and habits), influence the manifestation of breast cancer (Rouquayrol, 1994). Statistical models were constructed by Reynolds and Hurley (2003) to evaluate the high breast cancer incidences associated with socio-demographic and environmental characteristics. With the increase of urbanization and industrialization, environmental and ecological relations have been disrupted and unfavorable alterations have resulted due to the direct action of physical, chemical and biological agents triggered by humans. Rouquayrol (1994) stated that the exposure to a large number of carcinogenic substances through consumption, inhalation, absorption or introduction into the body (ingestion of medicines or by accidents) leading to breast cancer or generally cancer may be pointed out as a public health problem.

Fighting against breast cancer requires knowledge about the occurrence, the risk of exposures, consequences and variations in disease risk among the population. This seeks for an expert tool like GIS which is a promising option to establish relationships between environmental factors, regional exposures and individual health. The objective of this section is to identify the

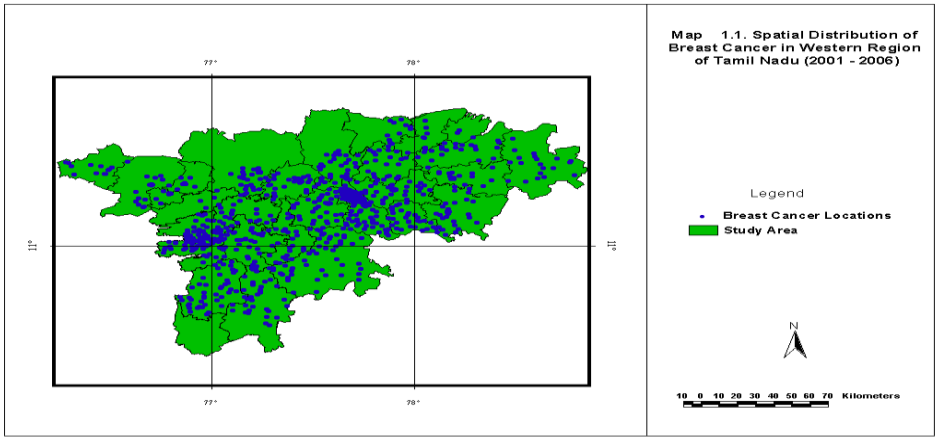
breast cancer risk areas in Tamil Nadu region through thematic maps.

II. MATERIALS AND METHODS

The data for the present cross-sectional study on cancer was collected from the records of National Cancer Registry Program, (NCRP), Bangalore, Government Hospitals of Coimbatore, Erode, Namakkal, Salem and Nilgiri, Tamil nadu, VNCC (Valavadi Naryanaswamy Cancer Centre), Oncology wing, G. Kuppuswamy Naidu Memorial Hospital, Coimbatore, Tamil nadu , Department of Oncology, Surgical Oncology and Radiation Oncology, Sri Ramakrishna Hospital, Coimbatore, Tamil Nadu for six years from 2001 to 2006. The cancer incidences from the Western region of Tamil Nadu were collected from hospital registers with respect to the study area.. The geographical location of each individual case (address of the patient) was geocoded in GIS environment and the latitude-longitude values were retrieved. Point map was prepared to visualize the distribution of breast cancer in the Western region of Tamil Nadu from 2001 to 2006. The population density was calculated for each taluk and the incidences based on population density were calculated and attributed. Based on this, a thematic map was prepared to classify the taluks into high incidences, moderate incidences and low incidences. All the analyses were performed using ArcGIS 9.1 (ESRI).

III. RESULT & DISCUSSION

The point map 1.1 shows the distribution of breast cancer in the Western region of Tamil Nadu. The maximum number of points was seen in the taluks of Coimbatore (North and South) and Erode than other taluks. This concentration may be due to the migration of the people from rural areas to the urban areas for their employment, industrialization, education, hospital facilities and also due to their change in lifestyle and environmental exposures.



The number of breast cancer records in each taluk were scrutinized, aggregated and presented in Table 1.2. From the Table 1.2, it was observed that breast cancer cases were reported in 28 taluks out of 29 taluks (no breast cancer cases in Valparai taluk) in the Western regions of Tamil Nadu. The total number of breast cancer cases was reported as 1,862 after omitting some of the incomplete records. For the present study, natural break data classification technique was used to classify the breast cancer incidence data for the preparation of thematic map. Data of the breast cancer for six years were classified as high incidence, moderate incidence and low incidence. The digitized map of the Western region of Tamil Nadu comprises of five districts and divided into 29 taluks. Each polygon of the map is considered as a taluk in the study area. The geocoded records were then transferred to the digital map using ArcGIS 9.1.

The polygons were classified based on natural break to prepare a thematic map of intensity for the breast cancer cases and is presented as Map 1.2. From the thematic map, it is observed that Coimbatore North and South taluks recorded the highest number of cases. Moderate incidence ranging from 118 to 234 were observed in Erode taluk, low cases in remaining twenty five taluks of the Western region of Tamil Nadu and with no incidence in Valparai taluk. From the results, it is observed that as the rate of population increases, the number of cases increase revealing that the cases are dependent on the population size. The rate may vary over time as urbanization increases and as centrification of population expands. Hence, total population for each taluk were scrutinized and used for calculating the breast cancer incidence rate.

Table 1.2.Breast Cancer Incidence Rate and Population Density for the Western Regions of Tamil Nadu from 2001

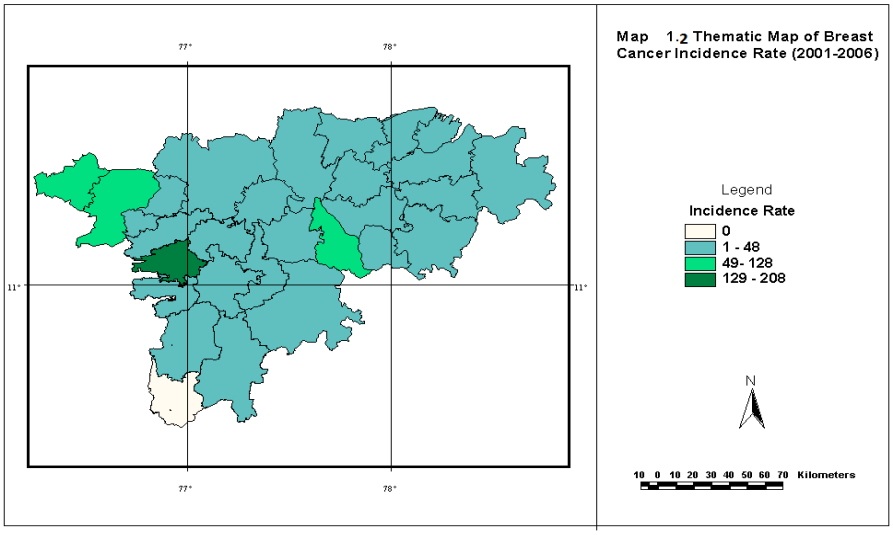
S.No	Districts	Taluks	Area in Sq km	Total Population	Population Density	Female Population	Breast Cancer Incidence	Incidence Rate for Female Population	Incidence Rate for Total Population
1.	COIMBATORE	Avinashi	671.19	252753	376.6	124578	55	44.149	21.760
		Coimbatore North	610.16	349225	572.34	170878	355	207.750	101.654
			593.82	1332789	2244.4	651031	301	46.234	22.584
		Coimbatore South	629.49	237805	377.8	117509	43	36.593	18.082
			882.53	393171	445.5	192462	80	41.566	20.347
		Mettupalayam	1217.37	544194	447.0	271139	91	33.562	16.722
		Palladam	679.10	677978	998.4	326067	117	35.882	17.257
		Pollachi	1563.13	388834	248.8	194015	77	39.687	19.802
		Tirupur	958.00	94962	99.1	48430	-	-	-
		Udumalpet							
		Valparai							
2.	ERODE	Bhavani	1506.80	423708	281.2	206328	43	20.841	10.148
		Dharapuram	2317.49	278783	120.3	139274	39	28.002	13.989
		Erode	753.15	706529	938.1	347478	195	56.119	27.599
		Gobi	714.70	361201	505.4	179347	50	27.879	13.842
		Perundurai	827.19	326782	395.1	160823	33	20.519	10.098
		Sathyamangalam	2316.31	287605	124.2	141585	32	22.601	11.126
3.	NAMAKKAL	Namakkal	1279.92	459296	358.8	226849	24	10.579	5.225
		Paramathi	532.66	186909	350.9	92987	39	41.941	20.866
		Rasipuram	826.33	317571	384.3	155627	20	12.851	6.298
		Thiruchengode	825.16	529686	641.9	258448	29	11.221	5.475
4.	SALEM	Sankagiri	726.44	223775	308.0	105330	6	5.696	2.681
		Yercaud	390.99	39080	100.0	19246	5	25.979	12.794
		Attur	1691.03	384642	227.5	189950	46	24.217	11.959
		Mettur	811	378337	466.5	177601	22	12.387	5.815
		Omalur	676.43	405302	599.2	189452	13	6.862	3.207
		Salem	975.18	1071211	1098.5	523102	18	3.441	1.680
5.	NILGIRIS	Coonoor	222.29	175067	787.6	87714	22	22.082	12.566
		Gudalur	734.51	98212	133.7	6893	4	58.030	4.073
		Kotagiri	423.90	113597	268.0	57862	17	29.380	14.965
		Ooty	1220.62	205633	168.5	103054	56	54.340	27.232

Incidence rate of breast cancer

$$\text{Incidence rate} = \frac{\text{Total number of breast cancer incidences}}{\text{Total population}} \times 100{,}000 \quad \ldots\ldots(1)$$

The calculated incidence rate was used and plotted on the thematic map of incidence rate in Western region of Tamil Nadu (Map 1.2). The natural break classification method was used to classify the area into high, moderate and low incidence rate. The incidence rate was found to be very high in the Coimbatore North taluk. The moderate incidence rate of breast cancer was observed in Ooty, Gudalur and Erode taluks in which the rate ranges from 49 to 128. The remaining 24 taluks have low incidence rate and no breast cancer incidence rate was observed in Valparai taluk as it has no reported breast cancer cases. This increase in incidence rate in Coimbatore North may be due to the industrialization and increase in hospital facilities, education, etc.; many people migrate temporarily from rural area to urban area.

Thematic maps for each year were collected individually and presented as maps from 1.3 to 1.11, to understand the significant regional variation with respect to the temporal changes on breast cancer cases in the study area. The natural break classification was adopted and classified into high, moderate and low incidences of breast cancer. For the year 2001 (Map 1.3), the high incidence rate of breast cancer was observed in Coimbatore (North and South) and Erode taluks. The moderate incidence rate of breast cancer was seen in Palladam, Pollachi, Tirupur and Udumalpet, and the taluks of Coonoor and Valparai showed no incidence. The remaining taluks were considered as low incidence area in the Western regions of TamilNadu.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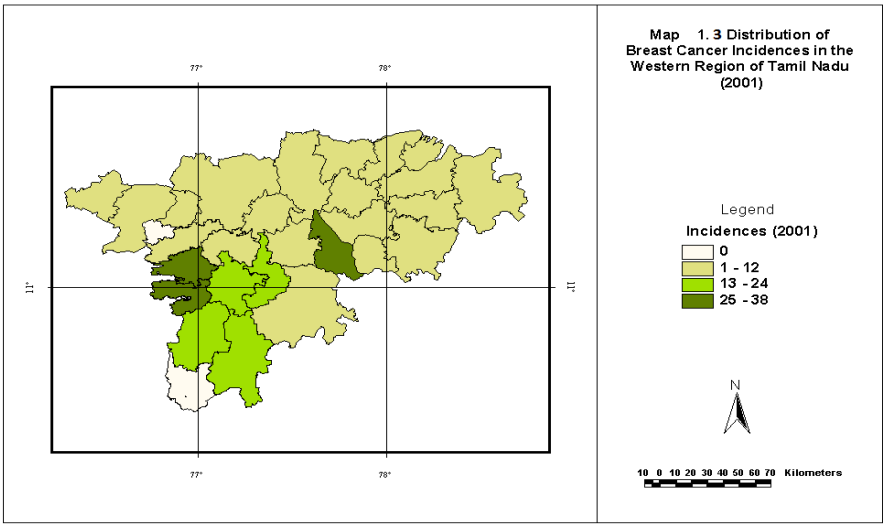
Map 1.2 Thematic Map of Breast Cancer Incidence Rate (2001-2006)
Legend
Incidence Rate
0
1 - 48
49- 128
129 - 208
N
10 0 10 20 30 40 50 60 70 Kilometers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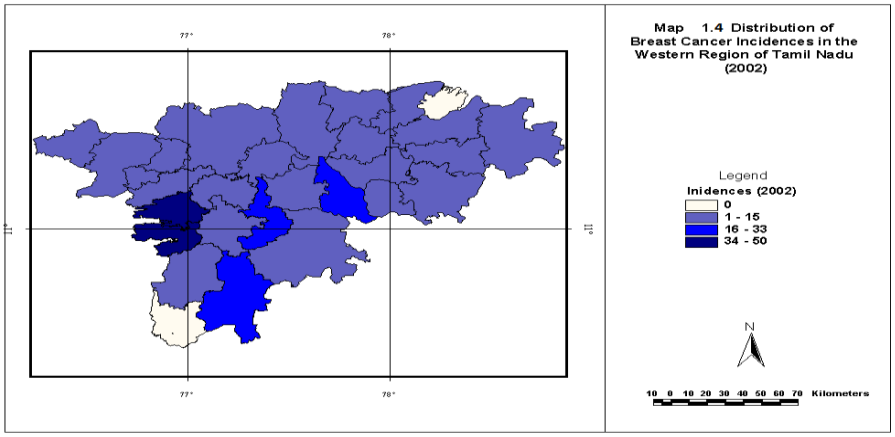
Map 1. 3 Distribution of Breast Cancer Incidences in the Western Region of Tamil Nadu (2001)
Legend
Incidences (2001)
0
1 - 12
13 - 24
25 - 38
N
10 0 10 20 30 40 50 60 70 Kilometers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77°
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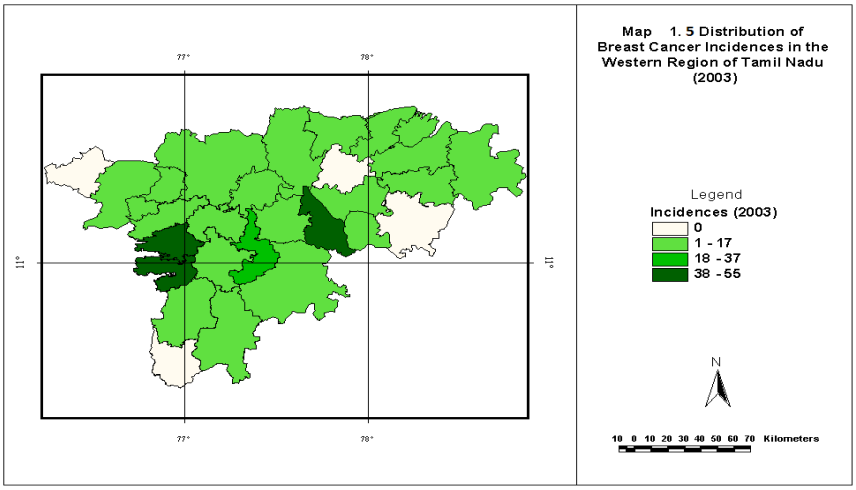
Map 1.4 Distribution of Breast Cancer Incidences in the Western Region of Tamil Nadu (2002)
Legend
Inidences (2002)
0
1 - 15
16 - 33
34 - 50
N
10 0 10 20 30 40 50 60 70 Kilometers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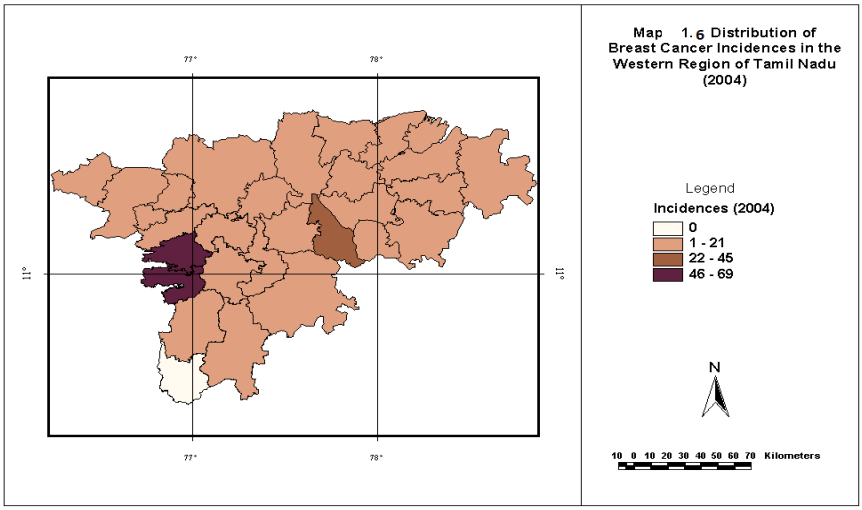
77°
78°
Map 1. 5 Distribution of Breast Cancer Incidences in the Western Region of Tamil Nadu (2003)
Legend
Incidences (2003)
0
1 - 17
18 - 37
38 - 55
N
10 0 10 20 30 40 50 60 70 Kilometers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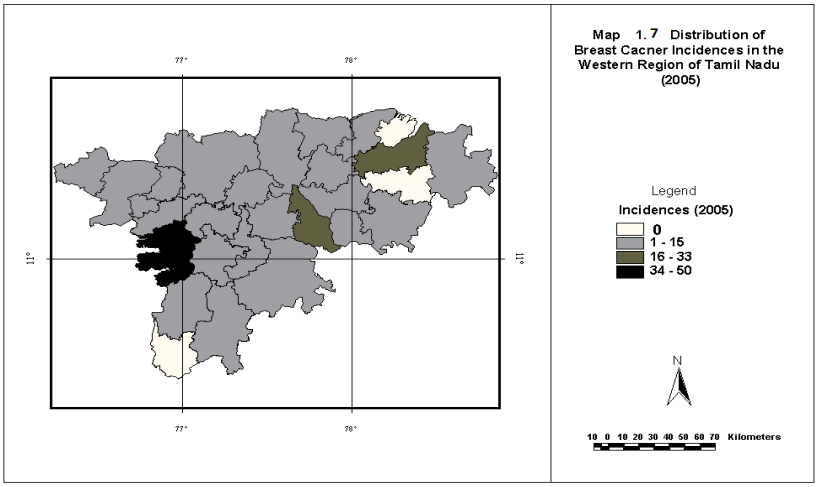
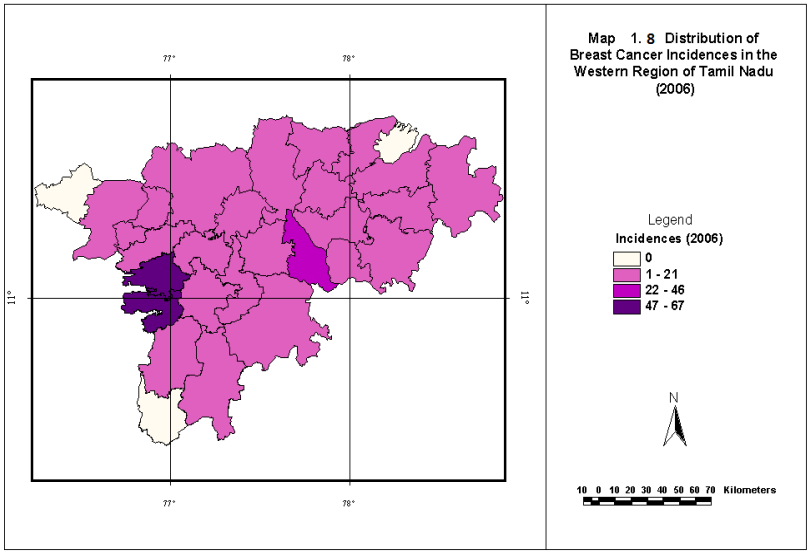
78°
11°
Map 1.6 Distribution of Breast Cancer Incidences in the Western Region of Tamil Nadu (2004)
Legend
Incidences (2004)
0
1 - 21
22 - 45
46 - 69
N
10 0 10 20 30 40 50 60 70 Kilometers


77°
78°
11°
Map 1.7 Distribution of Breast Cacner Incidences in the Western Region of Tamil Nadu (2005)
Legend
Incidences (2005)
0
1 - 15
16 - 33
34 - 50
N
10 0 10 20 30 40 50 60 70 Kilometers



For the year 2002, the thematic map (Map 1.4) showed the high breast cancer incidences in the taluks of Coimbatore North and South, with the moderate incidence in Erode, Tirupur and Udumalpet taluks. There was no incidence in taluks of Valparai and Yercaud. The remaining 22 taluks in the study area were considered as low incidence of breast cancer.

The thematic map of 2003 (Map 1.5), showed that high incidence was observed in Coimbatore (North and South) and Erode taluks and moderate incidence in Tirupur taluk. No incidence was reported in the taluks of Valparai, Gudalur, Sankagiri and Namakkal and the remaining taluks showed low incidence rate of breast cancer in the study area. In 2004 (Map 1.6), the high breast cancer incidences was observed in the taluks of Coimbatore North and South, with moderate incidence in Erode taluk. There was no incidence in Valparai taluk and the other 25 taluks was found to represent most of the regions in the study area with low incidence of breast cancer.

The thematic map of the year 2005 (Map 1.7) and 2006 (Map 1.8) showed high incidence of breast cancer in the taluks of Coimbatore North and South as seen in the previous year 2004. In 2005, moderate incidence was observed in Erode and Salem taluks and no incidence was seen in the taluks of Rasipuram, Valparai and Yercaud. The remaining 22 taluk showed low incidence rate of breast cancer in the study area. Whereas, in 2006, the moderate incidence rate was observed in Erode taluk and no incidence of breast cancer was seen in Gudalur, Valparai and Yercaud taluks. The remaining 23 taluks showed low incidence of breast cancer.

Increase in low incidence rate may be due to the awareness of the public by the health organizations, varying presence of hazards in the environment, demographics and lifestyle of the mobile population, subgroups of susceptible individuals, changes and advances in medical practice and health care management. The majority of the taluks showed low incidences in breast cancer while studying the thematic map for all the six years. The significant high incidence was observed in the Coimbatore taluk throughout the study period.

A tabulated summary of the breast cancer incidences in the taluks of the Western regions of Tamil Nadu is prepared and presented in Table 1.3. From the Table, it was observed that except Coimbatore (North and South) other taluks showed moderate or low incidences or fluctuations from moderate to low incidences of breast cancer. These taluks were also displayed fluctuations of moderate and high incidences both spatially and temporally. Low incidences were observed in most of the taluks of the study area and few taluks showed no incidence in breast cancer.

The breast cancer maps demonstrate that there exist spatial / temporal variations in the study region. This relatively stable method makes little difference in the appearance of the maps. Mason *et al.* (1975); Blot *et al.* (1977); Pickel *et al.* (1999) have reported the spatial variation of breast cancer mortality in United States. Prashanthi Devi and Balasubramanian (2006) have stated that the thematic map predicts the malaria risk in Salem district, India – a case control study using spatial analysis and modelling. Goodwin *et al.*, (1998) has reported that the geographical variation in mortality among white women in USA is due to the known risk factors such as age at first live birth. Breast cancer rates are rising in many Western countries, but deaths from the disease have decreased as a result of improved screening and treatment.

Table 1.3 Temporal Distribution of Breast Cancer Incidences in the Western Regions of Tamil Nadu from 2001 to 2006

Districts	Taluk	2001	2002	2003	2004	2005	2006
COIMBATORE	Avinashi	*	*	*	*	*	*
	Coimbatore North	***	***	***	***	***	***
	Coimbatore South	***	***	***	***	***	***
	Mettupalayam	*	*	*	*	*	*
	Palladam	**	*	*	*	*	*
	Pollachi	**	*	*	*	*	*
	Tirupur	**	**	**	*	*	*
	Udumalpet	**	**	*	*	*	*
	Valparai	---	---	---	---	---	---
ERODE	Bhavani	*	*	*	*	*	*
	Dharapuram	*	*	*	*	*	*
	Erode	***	**	***	**	**	**
	Gobi	*	*	*	*	*	*
	Perundurai	*	*	*	*	*	*
	Sathyamangalam	*	*	*	*	*	*
SALEM	Sankagiri	*	*	---	*	*	*
	Yercaud	*	---	*	*	---	---
	Attur	*	*	*	*	*	*
	Mettur	*	*	*	*	*	*
	Omalur	*	*	*	*	*	*
	Salem	*	*	*	*	**	*
NAMAKKAL	Namakkal	*	*	---	*	*	*
	Paramathi	*	*	*	*	*	*
	Rasipuram	*	*	*	*	---	*
	Thiruchengode	*	*	*	*	*	*
NILGIRIS	Coonoor	---	*	*	*	*	*
	Gudalur	*	*	----	*	*	---
	Kotagiri	*	*	*	*	*	*
	Ooty	*	*	*	*	*	*
	Low	20	22	21	25	22	23
	Moderate	4	3	1	1	2	1
	High	3	2	3	2	2	2
	No	2	2	4	1	3	3

* Low incidences
** Moderate incidences
*** High incidences

IV. CONCLUSION

From the observations, it is clear that the breast cancer incidence in the Western region of Tamil Nadu was found to be varying from one area to another, with high incidences in Coimbatore North and South taluks. The breast cancer in female and male is not uniform because it is sex-specific. However, the treatment for the female and male breast cancer was found to be similar. Therefore, a brief study with effective measures is required to control the breast cancer incidences.

Spatial distribution of any disease particularly cancer gives the current scenario offering information on intensity, location and spread. To make a precise decision, a temporal trend based on the historical information is required which estimates if the disease cases have increased / decreased over time. Using this trend, a futuristic prediction can be made for better implementation of plans.

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